Appendix E

Traffic Analysis Worksheets

Appendix E
Traffic Analysis Worksheets

2013 Existing

Appendix E
Traffic Analysis Worksheets

2013 Existing

Interstate 26

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-26 EB
Agency or Company	Atkins	Junction	1010-EB Off to C-D
Date Performed	3/20/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2013

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Freeway Number of Lanes, N	4	Downstream Adj Ramp	
☐ Yes	☐ On	Ramp Number of Lanes, N	1	☐ Yes	☐ On
☑ No	☐ Off	Acceleration Lane Length, L_A		☑ No	☐ Off
L_{up} =	ft	Deceleration Lane Length L_D	400	L_{down} =	ft
V_u =	veh/h	Freeway Volume, V_F	7294	V_D =	veh/h
		Ramp Volume, V_R	840		
		Freeway Free-Flow Speed, S_{FF}	60.0		
		Ramp Free-Flow Speed, S_{FR}	55.0		

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	7294	0.90	Level	10	0	0.952	1.00	8510
Ramp	840	0.90	Level	6	0	0.971	1.00	961
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 0.436 using Equation (Exhibit 13-7)

V_{12} = 4252 pc/h

V_3 or V_{av34} 2129 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	8510	Exhibit 13-8	9200	No
$V_{FO} = V_F - V_R$	7549	Exhibit 13-8	9200	No
V_R	961	Exhibit 13-10	2200	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	4252	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = 37.2 (pc/mi/ln)

LOS = E (Exhibit 13-2)

Speed Determination

D_s = 0.254 (Exhibit 13-12)

S_R= 55.4 mph (Exhibit 13-12)

S_0= 61.4 mph (Exhibit 13-12)

S = 58.3 mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-26 EB
Agency or Company	Atkins	Junction	1010-EB Off to C-D
Date Performed	3/20/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2013

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Freeway Number of Lanes, N: 4	☐ Yes ☐ On
☑ No ☐ Off	Ramp Number of Lanes, N: 1	☑ No ☐ Off
L_{up} = ft	Acceleration Lane Length, L_A	L_{down} = ft
V_u = veh/h	Deceleration Lane Length L_D: 400	V_D = veh/h
	Freeway Volume, V_F: 4771	
	Ramp Volume, V_R: 449	
	Freeway Free-Flow Speed, S_{FF}: 60.0	
	Ramp Free-Flow Speed, S_{FR}: 55.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	4771	0.90	Level	12	0	0.943	1.00	5619
Ramp	449	0.90	Level	9	0	0.957	1.00	521
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 0.436 using Equation (Exhibit 13-7)

V_{12} = 2744 pc/h

V_3 or V_{av34} 1437 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	5619	Exhibit 13-8	9200	No
$V_{FO} = V_F - V_R$	5098	Exhibit 13-8	9200	No
V_R	521	Exhibit 13-10	2200	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	2744	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = 24.3 (pc/mi/ln)

LOS = C (Exhibit 13-2)

Speed Determination

D_s = 0.215 (Exhibit 13-12)

S_R= 56.1 mph (Exhibit 13-12)

S_0= 64.1 mph (Exhibit 13-12)

S = 60.0 mph (Exhibit 13-13)

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-26 EB*
Agency or Company	*Atkins*	From/To	*1015-Avai/Rem CD Off to CD On*
Date Performed	*4/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2013*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*6454*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*10*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.952*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*4*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*60.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*60.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1882*	pc/h/ln
S	*58.6*	mph
D = v_p / S	*32.1*	pc/mi/ln
LOS	*D*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-26 EB*
Agency or Company	*Atkins*	From/To	*1015-Avai/Rem CD Off to CD On*
Date Performed	*4/25/2014*	Jurisdiction	
Analysis Time Period	*PM Peak*	Analysis Year	*2013*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*4322*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*12*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.943*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*4*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*60.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*60.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1273*	pc/h/ln
S	*60.0*	mph
D = v_p / S	*21.2*	pc/mi/ln
LOS	*C*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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RAMP ADD OR DROP LANE ANALYSIS (MAINLINE <55 MPH)

ATKINS

General Information

Date Performed:	3/20/2014	Freeway/Direction	I-26 EB C-D
Analysis Year	2013	Junction	EB Off to Aviation Ave
Analysis Time Period:	AM Peak	Segment ID	1020
Project Description:	Navy Base ICTF		

Inputs

	Mainline Upstream Ramp	Mainline Downstream Ramp	Ramp
Number of Lanes, N	1	1	1
Free-Flow Speed, FFS (mph)	55	55	45
Volume, V (veh/h)	840	400	440
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	6%	6%	6%
%RVs, P_R	0%	0%	0%

Performance Measures

	Upstream of Off-Ramp	Downstream of Off-Ramp	Off-Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.97	0.97	0.97
Demand Flow Rate, v_p (pc/h/ln)	961	458	504
Capacity Flow Rate, c (pc/h/ln)	2,200	2,200	2,100
v/c ratio	0.44	0.21	0.24
Density, D_{MD} (pc/mi/ln)	16.8	8.0	8.8
LOS	B	A	A

Formulas and Reference Material

$$f_{HV} = \frac{1}{1+P_T(E_T-1)+P_R(E_R-1)}$$ HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P}$$ HCM 2010, Equation 11-2

$$D_{MD} = \frac{0.0175*v_f}{N}$$ HCM 2010, Equation 13-26

Ramp Roadways Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

Diverge LOS Thresholds

LOS	Density (pc/mi/ln)
A	≤10
B	>10-20
C	>20-28
D	>28-35
E	>35
F	v/c > 1

Source: HCM 2010, Exhibit 13-2

RAMP ADD OR DROP LANE ANALYSIS (MAINLINE <55 MPH)

ATKINS

General Information

Date Performed:	3/20/2014	Freeway/Direction	I-26 EB C-D
Analysis Year	2013	Junction	EB Off to Aviation Ave
Analysis Time Period:	PM Peak	Segment ID	1020
Project Description:	Navy Base ICTF		

Inputs

	Mainline Upstream Ramp	Mainline Downstream Ramp	Ramp
Number of Lanes, N	1	1	1
Free-Flow Speed, FFS (mph)	55	55	45
Volume, V (veh/h)	449	262	187
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	9%	10%	6%
%RVs, P_R	0%	0%	0%

Performance Measures

	Upstream of Off-Ramp	Downstream of Off-Ramp	Off-Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.96	0.95	0.97
Demand Flow Rate, v_p (pc/h/ln)	521	306	214
Capacity Flow Rate, c (pc/h/ln)	2,200	2,200	2,100
v/c ratio	0.24	0.14	0.10
Density, D_{MD} (pc/mi/ln)	9.1	5.4	3.7
LOS	A	A	A

Formulas and Reference Material

$$f_{HV} = \frac{1}{1+P_T(E_T-1)+P_R(E_R-1)}$$ HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P}$$ HCM 2010, Equation 11-2

$$D_{MD} = \frac{0.0175*v_f}{N}$$ HCM 2010, Equation 13-26

Ramp Roadways Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

Diverge LOS Thresholds

LOS	Density (pc/mi/ln)
A	≤10
B	>10-20
C	>20-28
D	>28-35
E	>35
F	v/c > 1

Source: HCM 2010, Exhibit 13-2

BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-26 EB C-D*
Agency or Company	*Atkins*	From/To	*1025 - Avia Off to Avia WB On*
Date Performed	*4/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2013*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*800*	veh/h	Peak-Hour Factor, PHF	*0.90*	
AADT		veh/day	%Trucks and Buses, P_T	*6*	
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*	
Peak-Hr Direction Prop, D			General Terrain:	*Level*	
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*	

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.971*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*55.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*55.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*458*	pc/h/ln
S	*55.0*	mph
D = v_p / S	*8.3*	pc/mi/ln
LOS	*A*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-26 EB C-D*
Agency or Company	*Atkins*	From/To	*1025 - Avia Off to Avia WB On*
Date Performed	*4/25/2014*	Jurisdiction	
Analysis Time Period	*PM Peak*	Analysis Year	*2013*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*524*	veh/h	Peak-Hour Factor, PHF	*0.90*	
AADT		veh/day	%Trucks and Buses, P_T	*10*	
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*	
Peak-Hr Direction Prop, D			General Terrain:	*Level*	
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*	

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.952*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*55.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*55.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*306*	pc/h/ln
S	*55.0*	mph
D = v_p / S	*5.6*	pc/mi/ln
LOS	*A*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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RAMP ADD OR DROP LANE ANALYSIS (MAINLINE <55 MPH)

ATKINS

General Information

Date Performed:	3/20/2014	Freeway/Direction	I-26 EB C-D
Analysis Year	2013	Junction	WB Aviation EB On Loop
Analysis Time Period:	AM Peak	Segment ID	1030
Project Description:	Navy Base ICTF		

Inputs

	Mainline Upstream Ramp	Mainline Downstream Ramp	Ramp
Number of Lanes, N	1	1	1
Free-Flow Speed, FFS (mph)	55	55	25
Volume, V (veh/h)	400	683	283
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	6%	5%	2%
%RVs, P_R	0%	0%	0%

Performance Measures

	Upstream of Off-Ramp	Downstream of Off-Ramp	Off-Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.97	0.98	0.99
Demand Flow Rate, v_p (pc/h/ln)	458	778	318
Capacity Flow Rate, c (pc/h/ln)	2,200	2,200	1,900
v/c ratio	0.21	0.35	0.17
Density, D_{MD} (pc/mi/ln)	8.0	13.6	5.6
LOS	A	B	A

Formulas and Reference Material

$$f_{HV} = \frac{1}{1+P_T(E_T-1)+P_R(E_R-1)}$$ HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P}$$ HCM 2010, Equation 11-2

$$D_{MD} = \frac{0.0175*v_f}{N}$$ HCM 2010, Equation 13-26

Ramp Roadways Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

Diverge LOS Thresholds

LOS	Density (pc/mi/ln)
A	≤10
B	>10-20
C	>20-28
D	>28-35
E	>35
F	v/c > 1

Source: HCM 2010, Exhibit 13-2

RAMP ADD OR DROP LANE ANALYSIS (MAINLINE <55 MPH)

ATKINS

General Information

Date Performed:	3/20/2014	Freeway/Direction	I-26 EB C-D
Analysis Year	2013	Junction	WB Aviation EB On Loop
Analysis Time Period:	PM Peak	Segment ID	1030
Project Description:	Navy Base ICTF		

Inputs

	Mainline Upstream Ramp	Mainline Downstream Ramp	Ramp
Number of Lanes, N	1	1	1
Free-Flow Speed, FFS (mph)	55	55	25
Volume, V (veh/h)	262	712	450
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	10%	5%	2%
%RVs, P_R	0%	0%	0%

Performance Measures

	Upstream of Off-Ramp	Downstream of Off-Ramp	Off-Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.95	0.98	0.99
Demand Flow Rate, v_p (pc/h/ln)	306	811	505
Capacity Flow Rate, c (pc/h/ln)	2,200	2,200	1,900
v/c ratio	0.14	0.37	0.27
Density, D_{MD} (pc/mi/ln)	5.4	14.2	8.8
LOS	A	B	A

Formulas and Reference Material

$$f_{HV} = \frac{1}{1+P_T(E_T-1)+P_R(E_R-1)}$$ HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P}$$ HCM 2010, Equation 11-2

$$D_{MD} = \frac{0.0175*v_f}{N}$$ HCM 2010, Equation 13-26

Ramp Roadways Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

Diverge LOS Thresholds

LOS	Density (pc/mi/ln)
A	≤10
B	>10-20
C	>20-28
D	>28-35
E	>35
F	v/c > 1

Source: HCM 2010, Exhibit 13-2

Navy Base ICTF

FREEWAY WEAVING WORKSHEET

General Information

Analyst	AJR
Agency/Company	Atkins
Date Performed	3/20/2014
Analysis Time Period	AM Peak

Site Information

Freeway/Dir of Travel	I-26 EB - Aviation-Remount C-D
Weaving Segment Location	1040-EB Aviation to Remount
Analysis Year	2013

Project Description *Navy Base ICTF*

Inputs

Weaving configuration	One-Sided
Weaving number of lanes, N	2
Weaving segment length, L_S	535ft
Freeway free-flow speed, FFS	55 mph
Segment type	C-D Roadway/ Multilane Highways
Freeway minimum speed, S_{MIN}	15
Freeway maximum capacity, C_{IFL}	2250
Terrain type	Level

Conversions to pc/h Under Base Conditions

	V (veh/h)	PHF	Truck (%)	RV (%)	E_T	E_R	f_{HV}	f_p	v (pc/h)
V_{FF}	283	0.90	5	0	1.5	1.2	0.976	1.00	322
V_{RF}	197	0.90	8	0	1.5	1.2	0.962	1.00	228
V_{FR}	400	0.90	6	0	1.5	1.2	0.971	1.00	458
V_{RR}	0	0.90	5	0	1.5	1.2	0.976	1.00	0
V_{NW}	322							V =	1008
V_W	686								
VR	0.681								

Configuration Characteristics

Minimum maneuver lanes, N_{WL}	2 lc	Minimum weaving lane changes, LC_{MIN}	686 lc/h
Interchange density, ID	0.8 int/mi	Weaving lane changes, LC_W	724 lc/h
Minimum RF lane changes, LC_{RF}	1 lc/pc	Non-weaving lane changes, LC_{NW}	0 lc/h
Minimum FR lane changes, LC_{FR}	1 lc/pc	Total lane changes, LC_{ALL}	724 lc/h
Minimum RR lane changes, LC_{RR}	lc/pc	Non-weaving vehicle index, I_{NW}	14

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment flow rate, v	1008 pc/h	Weaving intensity factor, W	0.287
Weaving segment capacity, c_w	2976 veh/h	Weaving segment speed, S	46.6 mph
Weaving segment v/c ratio	0.330	Average weaving speed, S_W	46.1 mph
Weaving segment density, D	10.8 pc/mi/ln	Average non-weaving speed, S_{NW}	47.6 mph
Level of Service, LOS	A	Maximum weaving length, L_{MAX}	10012 ft

Notes

a. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments".
b. For volumes that exceed the weaving segment capacity, the level of service is "F".

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Navy Base ICTF

FREEWAY WEAVING WORKSHEET

General Information

Analyst	AJR
Agency/Company	Atkins
Date Performed	3/20/2014
Analysis Time Period	PM Peak

Site Information

Freeway/Dir of Travel	I-26 EB - Aviation-Remount C-D
Weaving Segment Location	1040-EB Aviation to Remount
Analysis Year	2013

Project Description *Navy Base ICTF*

Inputs

Weaving configuration	One-Sided
Weaving number of lanes, N	2
Weaving segment length, L_S	535ft
Freeway free-flow speed, FFS	55 mph
Segment type	C-D Roadway/ Multilane Highways
Freeway minimum speed, S_{MIN}	15
Freeway maximum capacity, C_{IFL}	2250
Terrain type	Level

Conversions to pc/h Under Base Conditions

	V (veh/h)	PHF	Truck (%)	RV (%)	E_T	E_R	f_{HV}	f_p	v (pc/h)
V_{FF}	450	0.90	5	0	1.5	1.2	0.976	1.00	513
V_{RF}	351	0.90	3	0	1.5	1.2	0.985	1.00	396
V_{FR}	262	0.90	10	0	1.5	1.2	0.952	1.00	306
V_{RR}	0	0.90	2	0	1.5	1.2	0.990	1.00	0
V_{NW}	513							V =	1215
V_W	702								
VR	0.578								

Configuration Characteristics

Minimum maneuver lanes, N_{WL}	2 lc	Minimum weaving lane changes, LC_{MIN}	702 lc/h
Interchange density, ID	0.8 int/mi	Weaving lane changes, LC_W	740 lc/h
Minimum RF lane changes, LC_{RF}	1 lc/pc	Non-weaving lane changes, LC_{NW}	10 lc/h
Minimum FR lane changes, LC_{FR}	1 lc/pc	Total lane changes, LC_{ALL}	750 lc/h
Minimum RR lane changes, LC_{RR}	lc/pc	Non-weaving vehicle index, I_{NW}	22

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment flow rate, v	1215 pc/h	Weaving intensity factor, W	0.295
Weaving segment capacity, c_w	3165 veh/h	Weaving segment speed, S	46.4 mph
Weaving segment v/c ratio	0.375	Average weaving speed, S_W	45.9 mph
Weaving segment density, D	13.1 pc/mi/ln	Average non-weaving speed, S_{NW}	47.0 mph
Level of Service, LOS	B	Maximum weaving length, L_{MAX}	8750 ft

Notes

a. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments".
b. For volumes that exceed the weaving segment capacity, the level of service is "F".

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-26 EB C-D*
Agency or Company	*Atkins*	From/To	*1045-Remount Off to Remount On*
Date Performed	*4/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2013*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*960*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*5*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.976*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*55.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*55.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*547*	pc/h/ln
S	*55.0*	mph
D = v_p / S	*9.9*	pc/mi/ln
LOS	*A*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-26 EB C-D*
Agency or Company	*Atkins*	From/To	*1045-Remount Off to Remount On*
Date Performed	*4/25/2014*	Jurisdiction	
Analysis Time Period	*PM Peak*	Analysis Year	*2013*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*1602*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*2*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.990*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*55.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*55.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*899*	pc/h/ln
S	*55.0*	mph
D = v_p / S	*16.3*	pc/mi/ln
LOS	*B*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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RAMP ADD OR DROP LANE ANALYSIS (MAINLINE <55 MPH)

ATKINS

General Information

Date Performed:	3/20/2014	Freeway/Direction	I-26 EB C-D
Analysis Year	2013	Junction	Remount EB On Loop
Analysis Time Period:	AM Peak	Segment ID	1050
Project Description:	Navy Base ICTF		

Inputs

	Mainline Upstream Ramp	Mainline Downstream Ramp	Ramp
Number of Lanes, N	1	1	1
Free-Flow Speed, FFS (mph)	55	55	25
Volume, V (veh/h)	480	819	339
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	5%	4%	4%
%RVs, P_R	0%	0%	0%

Performance Measures

	Upstream of Off-Ramp	Downstream of Off-Ramp	Off-Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.98	0.98	0.98
Demand Flow Rate, v_p (pc/h/ln)	547	928	384
Capacity Flow Rate, c (pc/h/ln)	2,200	2,200	1,900
v/c ratio	0.25	0.42	0.20
Density, D_{MD} (pc/mi/ln)	9.6	16.2	6.7
LOS	A	B	A

Formulas and Reference Material

$$f_{HV} = \frac{1}{1+P_T(E_T-1)+P_R(E_R-1)}$$ HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P}$$ HCM 2010, Equation 11-2

$$D_{MD} = \frac{0.0175*v_f}{N}$$ HCM 2010, Equation 13-26

Ramp Roadways Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

Diverge LOS Thresholds

LOS	Density (pc/mi/ln)
A	≤10
B	>10-20
C	>20-28
D	>28-35
E	>35
F	v/c > 1

Source: HCM 2010, Exhibit 13-2

RAMP ADD OR DROP LANE ANALYSIS (MAINLINE <55 MPH)

ATKINS

General Information

Date Performed:	3/20/2014	Freeway/Direction	I-26 EB C-D
Analysis Year	2013	Junction	Remount EB On Loop
Analysis Time Period:	PM Peak	Segment ID	1050
Project Description:	Navy Base ICTF		

Inputs

	Mainline Upstream Ramp	Mainline Downstream Ramp	Ramp
Number of Lanes, N	1	1	1
Free-Flow Speed, FFS (mph)	55	55	25
Volume, V (veh/h)	801	1,191	390
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	2%	3%	3%
%RVs, P_R	0%	0%	0%

Performance Measures

	Upstream of Off-Ramp	Downstream of Off-Ramp	Off-Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.99	0.99	0.99
Demand Flow Rate, v_p (pc/h/ln)	899	1,343	440
Capacity Flow Rate, c (pc/h/ln)	2,200	2,200	1,900
v/c ratio	0.41	0.61	0.23
Density, D_{MD} (pc/mi/ln)	15.7	23.5	7.7
LOS	B	C	A

Formulas and Reference Material

$$f_{HV} = \frac{1}{1+P_T(E_T-1)+P_R(E_R-1)}$$ HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P}$$ HCM 2010, Equation 11-2

$$D_{MD} = \frac{0.0175*v_f}{N}$$ HCM 2010, Equation 13-26

Ramp Roadways Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

Diverge LOS Thresholds

LOS	Density (pc/mi/ln)
A	≤10
B	>10-20
C	>20-28
D	>28-35
E	>35
F	v/c > 1

Source: HCM 2010, Exhibit 13-2

Navy Base ICTF

FREEWAY WEAVING WORKSHEET

General Information

Analyst	AJR
Agency/Company	Atkins
Date Performed	3/20/2014
Analysis Time Period	AM Peak

Site Information

Freeway/Dir of Travel	I-26 EB
Weaving Segment Location	1060-Avi-Rem C-D to 526 C-D
Analysis Year	2013

Project Description *Navy Base ICTF*

Inputs

Weaving configuration	One-Sided	Segment type	Freeway
Weaving number of lanes, N	5	Freeway minimum speed, S_{MIN}	15
Weaving segment length, L_S	1850ft	Freeway maximum capacity, C_{IFL}	2300
Freeway free-flow speed, FFS	60 mph	Terrain type	Level

Conversions to pc/h Under Base Conditions

	V (veh/h)	PHF	Truck (%)	RV (%)	E_T	E_R	f_{HV}	f_p	v (pc/h)
V_{FF}	3696	0.90	2	0	1.5	1.2	0.990	1.00	4148
V_{RF}	469	0.90	2	0	1.5	1.2	0.990	1.00	526
V_{FR}	2758	0.90	22	0	1.5	1.2	0.901	1.00	3402
V_{RR}	350	0.90	9	0	1.5	1.2	0.957	1.00	406
V_{NW}	4554							V =	8482
V_W	3928								
VR	0.463								

Configuration Characteristics

Minimum maneuver lanes, N_{WL}	2 lc	Minimum weaving lane changes, LC_{MIN}	lc/h
Interchange density, ID	0.7 int/mi	Weaving lane changes, LC_W	lc/h
Minimum RF lane changes, LC_{RF}	2 lc/pc	Non-weaving lane changes, LC_{NW}	lc/h
Minimum FR lane changes, LC_{FR}	0 lc/pc	Total lane changes, LC_{ALL}	lc/h
Minimum RR lane changes, LC_{RR}	lc/pc	Non-weaving vehicle index, I_{NW}	

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment flow rate, v	8482 pc/h	Weaving intensity factor, W	
Weaving segment capacity, c_w	5131 veh/h	Weaving segment speed, S	mph
Weaving segment v/c ratio	1.637	Average weaving speed, S_W	mph
Weaving segment density, D	pc/mi/ln	Average non-weaving speed, S_{NW}	mph
Level of Service, LOS	F	Maximum weaving length, L_{MAX}	7398 ft

Notes

a. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments".
b. For volumes that exceed the weaving segment capacity, the level of service is "F".

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Navy Base ICTF

FREEWAY WEAVING WORKSHEET

General Information

Analyst	AJR
Agency/Company	Atkins
Date Performed	3/20/2014
Analysis Time Period	PM Peak

Site Information

Freeway/Dir of Travel	I-26 EB
Weaving Segment Location	1060-Avi-Rem C-D to 526 C-D
Analysis Year	2013

Project Description *Navy Base ICTF*

Inputs

Weaving configuration	One-Sided	Segment type	Freeway
Weaving number of lanes, N	5	Freeway minimum speed, S_{MIN}	15
Weaving segment length, L_S	1850ft	Freeway maximum capacity, C_{IFL}	2300
Freeway free-flow speed, FFS	60 mph	Terrain type	Level

Conversions to pc/h Under Base Conditions

	V (veh/h)	PHF	Truck (%)	RV (%)	E_T	E_R	f_{HV}	f_p	v (pc/h)
V_{FF}	2353	0.90	4	0	1.5	1.2	0.980	1.00	2667
V_{RF}	649	0.90	2	0	1.5	1.2	0.990	1.00	728
V_{FR}	1969	0.90	22	0	1.5	1.2	0.901	1.00	2428
V_{RR}	542	0.90	5	0	1.5	1.2	0.976	1.00	617
V_{NW}	3284							V =	6440
V_W	3156								
VR	0.490								

Configuration Characteristics

Minimum maneuver lanes, N_{WL}	2 lc	Minimum weaving lane changes, LC_{MIN}	lc/h
Interchange density, ID	0.7 int/mi	Weaving lane changes, LC_W	lc/h
Minimum RF lane changes, LC_{RF}	2 lc/pc	Non-weaving lane changes, LC_{NW}	lc/h
Minimum FR lane changes, LC_{FR}	0 lc/pc	Total lane changes, LC_{ALL}	lc/h
Minimum RR lane changes, LC_{RR}	lc/pc	Non-weaving vehicle index, I_{NW}	

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment flow rate, v	6440 pc/h	Weaving intensity factor, W	
Weaving segment capacity, c_w	4801 veh/h	Weaving segment speed, S	mph
Weaving segment v/c ratio	1.315	Average weaving speed, S_W	mph
Weaving segment density, D	pc/mi/ln	Average non-weaving speed, S_{NW}	mph
Level of Service, LOS	F	Maximum weaving length, L_{MAX}	7711 ft

Notes

a. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments".
b. For volumes that exceed the weaving segment capacity, the level of service is "F".

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-26 EB*
Agency or Company	*Atkins*	From/To	*1065 - I-526 CD Off to CD On*
Date Performed	*4/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2013*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*4165*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*2*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.990*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*3*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*60.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*60.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1558*	pc/h/ln
S	*60.0*	mph
D = v_p / S	*26.0*	pc/mi/ln
LOS	*C*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-26 EB*
Agency or Company	*Atkins*	From/To	*1065 - I-526 CD Off to CD On*
Date Performed	*4/25/2014*	Jurisdiction	
Analysis Time Period	*PM Peak*	Analysis Year	*2013*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*3002*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*3*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.985*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*3*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*60.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*60.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1129*	pc/h/ln
S	*60.0*	mph
D = v_p / S	*18.8*	pc/mi/ln
LOS	*C*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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RAMP ADD OR DROP LANE ANALYSIS (MAINLINE <55 MPH)

ATKINS

General Information

Date Performed:	3/20/2014	Freeway/Direction	I-26 EB C-D
Analysis Year	2013	Junction	EB Off to I-526 WB
Analysis Time Period:	AM Peak	Segment ID	1070
Project Description:	Navy Base ICTF		

Inputs

	Mainline Upstream Ramp	Mainline Downstream Ramp	Ramp
Number of Lanes, N	2	1	1
Free-Flow Speed, FFS (mph)	55	55	45
Volume, V (veh/h)	3,108	1,174	1,934
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	20%	29%	15%
%RVs, P_R	0%	0%	0%

Performance Measures

	Upstream of Off-Ramp	Downstream of Off-Ramp	Off-Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.91	0.87	0.93
Demand Flow Rate, v_p (pc/h/ln)	1,899	1,494	2,310
Capacity Flow Rate, c (pc/h/ln)	2,200	2,200	2,100
v/c ratio	0.86	0.68	1.10
Density, D_{MD} (pc/mi/ln)	33.2	26.1	40.4
LOS	D	C	F

Formulas and Reference Material

$$f_{HV} = \frac{1}{1+P_T(E_T-1)+P_R(E_R-1)}$$ HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P}$$ HCM 2010, Equation 11-2

$$D_{MD} = \frac{0.0175*v_f}{N}$$ HCM 2010, Equation 13-26

Ramp Roadways Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

Diverge LOS Thresholds

LOS	Density (pc/mi/ln)
A	≤10
B	>10-20
C	>20-28
D	>28-35
E	>35
F	v/c > 1

Source: HCM 2010, Exhibit 13-2

RAMP ADD OR DROP LANE ANALYSIS (MAINLINE <55 MPH)

ATKINS

General Information

Date Performed:	3/20/2014	Freeway/Direction	I-26 EB C-D
Analysis Year	2013	Junction	EB Off to I-526 WB
Analysis Time Period:	PM Peak	Segment ID	1070
Project Description:	Navy Base ICTF		

Inputs

	Mainline Upstream Ramp	Mainline Downstream Ramp	Ramp
Number of Lanes, N	2	1	1
Free-Flow Speed, FFS (mph)	55	55	45
Volume, V (veh/h)	2,511	960	1,551
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	18%	17%	19%
%RVs, P_R	0%	0%	0%

Performance Measures

	Upstream of Off-Ramp	Downstream of Off-Ramp	Off-Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.92	0.92	0.91
Demand Flow Rate, v_p (pc/h/ln)	1,521	1,157	1,887
Capacity Flow Rate, c (pc/h/ln)	2,200	2,200	2,100
v/c ratio	0.69	0.53	0.90
Density, D_{MD} (pc/mi/ln)	26.6	20.2	33.0
LOS	C	C	D

Formulas and Reference Material

$$f_{HV} = \frac{1}{1+P_T(E_T-1)+P_R(E_R-1)}$$ HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P}$$ HCM 2010, Equation 11-2

$$D_{MD} = \frac{0.0175*v_f}{N}$$ HCM 2010, Equation 13-26

Ramp Roadways Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

Diverge LOS Thresholds

LOS	Density (pc/mi/ln)
A	≤10
B	>10-20
C	>20-28
D	>28-35
E	>35
F	v/c > 1

Source: HCM 2010, Exhibit 13-2

BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-26 EB C-D*
Agency or Company	*Atkins*	From/To	*1075-I526 WB Off to I526 WB On*
Date Performed	*4/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2013*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*2348*	veh/h	Peak-Hour Factor, PHF	*0.90*	
AADT		veh/day	%Trucks and Buses, P_T	*29*	
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*	
Peak-Hr Direction Prop, D			General Terrain:	*Level*	
DDHV = AADT x K x D		veh/h	Grade % Length	*mi*	
			Up/Down %		

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.873*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*55.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*55.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1494*	pc/h/ln
S	*55.0*	mph
D = v_p / S	*27.2*	pc/mi/ln
LOS	*D*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-26 EB C-D*
Agency or Company	*Atkins*	From/To	*1075-I526 WB Off to I526 WB On*
Date Performed	*4/25/2014*	Jurisdiction	
Analysis Time Period	*PM Peak*	Analysis Year	*2013*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*1920*	veh/h	Peak-Hour Factor, PHF	*0.90*	
AADT		veh/day	%Trucks and Buses, P_T	*17*	
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*	
Peak-Hr Direction Prop, D			General Terrain:	*Level*	
DDHV = AADT x K x D		veh/h	Grade % Length	*mi*	
			Up/Down %		

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.922*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*55.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*55.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1157*	pc/h/ln
S	*55.0*	mph
D = v_p / S	*21.0*	pc/mi/ln
LOS	*C*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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Navy Base ICTF

FREEWAY WEAVING WORKSHEET

General Information

Analyst	AJR
Agency/Company	Atkins
Date Performed	3/20/2014
Analysis Time Period	AM Peak

Site Information

Freeway/Dir of Travel	I-26 EB C-D
Weaving Segment Location	1080 - I-526 WB to I-526 EB
Analysis Year	2013

Project Description *Navy Base ICTF*

Inputs

Weaving configuration	One-Sided
Weaving number of lanes, N	2
Weaving segment length, L_S	620ft
Freeway free-flow speed, FFS	55 mph
Segment type	C-D Roadway/ Multilane Highways
Freeway minimum speed, S_{MIN}	15
Freeway maximum capacity, C_{IFL}	2250
Terrain type	Level

Conversions to pc/h Under Base Conditions

	V (veh/h)	PHF	Truck (%)	RV (%)	E_T	E_R	f_{HV}	f_p	v (pc/h)
V_{FF}	0	0.90	1	0	1.5	1.2	0.995	1.00	0
V_{RF}	520	0.90	15	0	1.5	1.2	0.930	1.00	621
V_{FR}	1174	0.90	29	0	1.5	1.2	0.873	1.00	1494
V_{RR}	0	0.90	1	0	1.5	1.2	0.995	1.00	0
V_{NW}	0							V =	2115
V_W	2115								
VR	1.000								

Configuration Characteristics

Minimum maneuver lanes, N_{WL}	2 lc	Minimum weaving lane changes, LC_{MIN}	2115 lc/h
Interchange density, ID	0.8 int/mi	Weaving lane changes, LC_W	2160 lc/h
Minimum RF lane changes, LC_{RF}	1 lc/pc	Non-weaving lane changes, LC_{NW}	0 lc/h
Minimum FR lane changes, LC_{FR}	1 lc/pc	Total lane changes, LC_{ALL}	2160 lc/h
Minimum RR lane changes, LC_{RR}	lc/pc	Non-weaving vehicle index, I_{NW}	0

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment flow rate, v	2115 pc/h	Weaving intensity factor, W	0.605
Weaving segment capacity, c_w	2388 veh/h	Weaving segment speed, S	39.9 mph
Weaving segment v/c ratio	0.881	Average weaving speed, S_W	39.9 mph
Weaving segment density, D	26.5 pc/mi/ln	Average non-weaving speed, S_{NW}	34.7 mph
Level of Service, LOS	C	Maximum weaving length, L_{MAX}	14232 ft

Notes

a. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments".
b. For volumes that exceed the weaving segment capacity, the level of service is "F".

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Navy Base ICTF

FREEWAY WEAVING WORKSHEET

General Information

Analyst	AJR
Agency/Company	Atkins
Date Performed	3/20/2014
Analysis Time Period	PM Peak

Site Information

Freeway/Dir of Travel	I-26 EB C-D
Weaving Segment Location	1080 - I-526 WB to I-526 EB
Analysis Year	2013

Project Description *Navy Base ICTF*

Inputs

Weaving configuration	One-Sided
Weaving number of lanes, N	2
Weaving segment length, L_S	620ft
Freeway free-flow speed, FFS	55 mph
Segment type	C-D Roadway/ Multilane Highways
Freeway minimum speed, S_{MIN}	15
Freeway maximum capacity, C_{IFL}	2250
Terrain type	Level

Conversions to pc/h Under Base Conditions

	V (veh/h)	PHF	Truck (%)	RV (%)	E_T	E_R	f_{HV}	f_p	v (pc/h)
V_{FF}	0	0.90	0	0	1.5	1.2	1.000	1.00	0
V_{RF}	458	0.90	14	0	1.5	1.2	0.935	1.00	545
V_{FR}	960	0.90	17	0	1.5	1.2	0.922	1.00	1157
V_{RR}	0	0.90	0	0	1.5	1.2	1.000	1.00	0
V_{NW}	0							V =	1702
V_W	1702								
VR	1.000								

Configuration Characteristics

Minimum maneuver lanes, N_{WL}	2 lc	Minimum weaving lane changes, LC_{MIN}	1702 lc/h
Interchange density, ID	0.8 int/mi	Weaving lane changes, LC_W	1747 lc/h
Minimum RF lane changes, LC_{RF}	1 lc/pc	Non-weaving lane changes, LC_{NW}	0 lc/h
Minimum FR lane changes, LC_{FR}	1 lc/pc	Total lane changes, LC_{ALL}	1747 lc/h
Minimum RR lane changes, LC_{RR}	lc/pc	Non-weaving vehicle index, I_{NW}	0

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment flow rate, v	1702 pc/h	Weaving intensity factor, W	0.512
Weaving segment capacity, c_w	2400 veh/h	Weaving segment speed, S	41.5 mph
Weaving segment v/c ratio	0.709	Average weaving speed, S_W	41.5 mph
Weaving segment density, D	20.5 pc/mi/ln	Average non-weaving speed, S_{NW}	38.7 mph
Level of Service, LOS	B	Maximum weaving length, L_{MAX}	14232 ft

Notes

a. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments".
b. For volumes that exceed the weaving segment capacity, the level of service is "F".

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-26 EB C-D*
Agency or Company	*Atkins*	From/To	*1085-I526 EB Off to I526 EB On*
Date Performed	*4/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2013*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*1040*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*15*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.930*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*55.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*55.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*621*	pc/h/ln
S	*55.0*	mph
D = v_p / S	*11.3*	pc/mi/ln
LOS	*B*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-26 EB C-D*
Agency or Company	*Atkins*	From/To	*1085-I526 EB Off to I526 EB On*
Date Performed	*4/25/2014*	Jurisdiction	
Analysis Time Period	*PM Peak*	Analysis Year	*2013*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*916*	veh/h	Peak-Hour Factor, PHF	*0.90*	
AADT		veh/day	%Trucks and Buses, P_T	*14*	
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*	
Peak-Hr Direction Prop, D			General Terrain:	*Level*	
DDHV = AADT x K x D		veh/h	Grade % Length	*mi*	
			Up/Down %		

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.935*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*55.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*55.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*545*	pc/h/ln
S	*55.0*	mph
D = v_p / S	*9.9*	pc/mi/ln
LOS	*A*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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RAMP ADD OR DROP LANE ANALYSIS (MAINLINE <55 MPH)

ATKINS

General Information

Date Performed:	3/20/2014	Freeway/Direction	I-26 EB
Analysis Year	2013	Junction	I-526 EB Ramp Split
Analysis Time Period:	AM Peak	Segment ID	1088
Project Description:	Navy Base ICTF		

Inputs

	Mainline Upstream Ramp	Mainline Downstream Ramp	Ramp
Number of Lanes, N	2	2	1
Free-Flow Speed, FFS (mph)	55	55	55
Volume, V (veh/h)	1,819	1,528	291
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	7%	7%	3%
%RVs, P_R	0%	0%	0%

Performance Measures

	Upstream of Off-Ramp	Downstream of Off-Ramp	Off-Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.97	0.97	0.99
Demand Flow Rate, v_p (pc/h/ln)	1,046	879	328
Capacity Flow Rate, c (pc/h/ln)	2,200	2,200	2,200
v/c ratio	0.48	0.40	0.15
Density, D_{MD} (pc/mi/ln)	18.3	15.4	5.7
LOS	B	B	A

Formulas and Reference Material

$$f_{HV} = \frac{1}{1+P_T(E_T-1)+P_R(E_R-1)}$$ HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P}$$ HCM 2010, Equation 11-2

$$D_{MD} = \frac{0.0175*v_f}{N}$$ HCM 2010, Equation 13-26

Ramp Roadways Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

Diverge LOS Thresholds

LOS	Density (pc/mi/ln)
A	≤10
B	>10-20
C	>20-28
D	>28-35
E	>35
F	v/c > 1

Source: HCM 2010, Exhibit 13-2

RAMP ADD OR DROP LANE ANALYSIS (MAINLINE <55 MPH)

ATKINS

General Information

Date Performed:	3/20/2014	Freeway/Direction	I-26 EB
Analysis Year	2013	Junction	I-526 EB Ramp Split
Analysis Time Period:	PM Peak	Segment ID	1088
Project Description:	Navy Base ICTF		

Inputs

	Mainline Upstream Ramp	Mainline Downstream Ramp	Ramp
Number of Lanes, N	2	2	1
Free-Flow Speed, FFS (mph)	55	55	55
Volume, V (veh/h)	2,102	1,767	335
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	8%	9%	3%
%RVs, P_R	0%	0%	0%

Performance Measures

	Upstream of Off-Ramp	Downstream of Off-Ramp	Off-Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.96	0.96	0.99
Demand Flow Rate, v_p (pc/h/ln)	1,214	1,026	378
Capacity Flow Rate, c (pc/h/ln)	2,200	2,200	2,200
v/c ratio	0.55	0.47	0.17
Density, D_{MD} (pc/mi/ln)	21.2	18.0	6.6
LOS	C	B	A

Formulas and Reference Material

$$f_{HV} = \frac{1}{1+P_T(E_T-1)+P_R(E_R-1)}$$ HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P}$$ HCM 2010, Equation 11-2

$$D_{MD} = \frac{0.0175*v_f}{N}$$ HCM 2010, Equation 13-26

Ramp Roadways Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

Diverge LOS Thresholds

LOS	Density (pc/mi/ln)
A	≤10
B	>10-20
C	>20-28
D	>28-35
E	>35
F	v/c > 1

Source: HCM 2010, Exhibit 13-2

RAMP ADD OR DROP LANE ANALYSIS (MAINLINE <55 MPH)

ATKINS

General Information

Date Performed:	3/20/2014	Freeway/Direction	I-26 EB C-D
Analysis Year	2013	Junction	I-526 EB On
Analysis Time Period:	AM Peak	Segment ID	1090
Project Description:	Navy Base ICTF		

Inputs

	Mainline Upstream Ramp	Mainline Downstream Ramp	Ramp
Number of Lanes, N	1	1	1
Free-Flow Speed, FFS (mph)	55	55	45
Volume, V (veh/h)	520	811	291
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	15%	11%	3%
%RVs, P_R	0%	0%	0%

Performance Measures

	Upstream of Off-Ramp	Downstream of Off-Ramp	Off-Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.93	0.95	0.99
Demand Flow Rate, v_p (pc/h/ln)	621	951	328
Capacity Flow Rate, c (pc/h/ln)	2,200	2,200	2,100
v/c ratio	0.28	0.43	0.16
Density, D_{MD} (pc/mi/ln)	10.9	16.6	5.7
LOS	B	B	A

Formulas and Reference Material

$$f_{HV} = \frac{1}{1+P_T(E_T-1)+P_R(E_R-1)}$$ HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P}$$ HCM 2010, Equation 11-2

$$D_{MD} = \frac{0.0175*v_f}{N}$$ HCM 2010, Equation 13-26

Ramp Roadways Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

Diverge LOS Thresholds

LOS	Density (pc/mi/ln)
A	≤10
B	>10-20
C	>20-28
D	>28-35
E	>35
F	v/c > 1

Source: HCM 2010, Exhibit 13-2

RAMP ADD OR DROP LANE ANALYSIS (MAINLINE <55 MPH)

ATKINS

General Information

Date Performed:	3/20/2014	Freeway/Direction	I-26 EB C-D
Analysis Year	2013	Junction	I-526 EB On
Analysis Time Period:	PM Peak	Segment ID	1090
Project Description:	Navy Base ICTF		

Inputs

	Mainline Upstream Ramp	Mainline Downstream Ramp	Ramp
Number of Lanes, N	1	1	1
Free-Flow Speed, FFS (mph)	55	55	45
Volume, V (veh/h)	458	793	335
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	14%	9%	3%
%RVs, P_R	0%	0%	0%

Performance Measures

	Upstream of Off-Ramp	Downstream of Off-Ramp	Off-Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.93	0.96	0.99
Demand Flow Rate, v_p (pc/h/ln)	545	921	378
Capacity Flow Rate, c (pc/h/ln)	2,200	2,200	2,100
v/c ratio	0.25	0.42	0.18
Density, D_{MD} (pc/mi/ln)	9.5	16.1	6.6
LOS	A	B	A

Formulas and Reference Material

$$f_{HV} = \frac{1}{1+P_T(E_T-1)+P_R(E_R-1)}$$ HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P}$$ HCM 2010, Equation 11-2

$$D_{MD} = \frac{0.0175*v_f}{N}$$ HCM 2010, Equation 13-26

Ramp Roadways Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

Diverge LOS Thresholds

LOS	Density (pc/mi/ln)
A	≤10
B	>10-20
C	>20-28
D	>28-35
E	>35
F	v/c > 1

Source: HCM 2010, Exhibit 13-2

Navy Base ICTF

FREEWAY WEAVING WORKSHEET

General Information

Analyst	AJR
Agency/Company	Atkins
Date Performed	3/20/2014
Analysis Time Period	AM Peak

Site Information

Freeway/Dir of Travel	I-26 EB
Weaving Segment Location	1100 - I-526 CD to Montague SB
Analysis Year	2013

Project Description *Navy Base ICTF*

Inputs

Weaving configuration	One-Sided
Weaving number of lanes, N	4
Weaving segment length, L_S	1550ft
Freeway free-flow speed, FFS	60 mph
Segment type	Freeway
Freeway minimum speed, S_{MIN}	15
Freeway maximum capacity, C_{IFL}	2300
Terrain type	Level

Conversions to pc/h Under Base Conditions

	V (veh/h)	PHF	Truck (%)	RV (%)	E_T	E_R	f_{HV}	f_p	v (pc/h)
V_{FF}	3710	0.90	2	0	1.5	1.2	0.990	1.00	4163
V_{RF}	723	0.90	9	0	1.5	1.2	0.957	1.00	839
V_{FR}	455	0.90	4	0	1.5	1.2	0.980	1.00	516
V_{RR}	88	0.90	27	0	1.5	1.2	0.881	1.00	111
V_{NW}	4274							V =	5629
V_W	1355								
VR	0.241								

Configuration Characteristics

Minimum maneuver lanes, N_{WL}	2 lc	Minimum weaving lane changes, LC_{MIN}	1355 lc/h
Interchange density, ID	0.8 int/mi	Weaving lane changes, LC_W	1708 lc/h
Minimum RF lane changes, LC_{RF}	1 lc/pc	Non-weaving lane changes, LC_{NW}	950 lc/h
Minimum FR lane changes, LC_{FR}	1 lc/pc	Total lane changes, LC_{ALL}	2658 lc/h
Minimum RR lane changes, LC_{RR}	lc/pc	Non-weaving vehicle index, I_{NW}	530

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment flow rate, v	5629 pc/h	Weaving intensity factor, W	0.346
Weaving segment capacity, c_w	8075 veh/h	Weaving segment speed, S	44.6 mph
Weaving segment v/c ratio	0.690	Average weaving speed, S_W	48.4 mph
Weaving segment density, D	31.6 pc/mi/ln	Average non-weaving speed, S_{NW}	43.5 mph
Level of Service, LOS	D	Maximum weaving length, L_{MAX}	4957 ft

Notes

a. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments".
b. For volumes that exceed the weaving segment capacity, the level of service is "F".

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Navy Base ICTF

FREEWAY WEAVING WORKSHEET

General Information

Analyst	AJR
Agency/Company	Atkins
Date Performed	3/20/2014
Analysis Time Period	PM Peak

Site Information

Freeway/Dir of Travel	I-26 EB
Weaving Segment Location	1100 - I-526 CD to Montague SB
Analysis Year	2013

Project Description *Navy Base ICTF*

Inputs

Weaving configuration	One-Sided
Weaving number of lanes, N	4
Weaving segment length, L_S	1550ft
Freeway free-flow speed, FFS	60 mph
Segment type	Freeway
Freeway minimum speed, S_{MIN}	15
Freeway maximum capacity, C_{IFL}	2300
Terrain type	Level

Conversions to pc/h Under Base Conditions

	V (veh/h)	PHF	Truck (%)	RV (%)	E_T	E_R	f_{HV}	f_p	v (pc/h)
V_{FF}	2337	0.90	3	0	1.5	1.2	0.985	1.00	2636
V_{RF}	617	0.90	8	0	1.5	1.2	0.962	1.00	713
V_{FR}	665	0.90	4	0	1.5	1.2	0.980	1.00	754
V_{RR}	176	0.90	12	0	1.5	1.2	0.943	1.00	207
V_{NW}	2843							V =	4310
V_W	1467								
VR	0.340								

Configuration Characteristics

Minimum maneuver lanes, N_{WL}	2 lc	Minimum weaving lane changes, LC_{MIN}	1467 lc/h
Interchange density, ID	0.8 int/mi	Weaving lane changes, LC_W	1820 lc/h
Minimum RF lane changes, LC_{RF}	1 lc/pc	Non-weaving lane changes, LC_{NW}	655 lc/h
Minimum FR lane changes, LC_{FR}	1 lc/pc	Total lane changes, LC_{ALL}	2475 lc/h
Minimum RR lane changes, LC_{RR}	lc/pc	Non-weaving vehicle index, I_{NW}	353

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment flow rate, v	4310 pc/h	Weaving intensity factor, W	0.327
Weaving segment capacity, c_w	6947 veh/h	Weaving segment speed, S	45.7 mph
Weaving segment v/c ratio	0.611	Average weaving speed, S_W	48.9 mph
Weaving segment density, D	23.6 pc/mi/ln	Average non-weaving speed, S_{NW}	44.3 mph
Level of Service, LOS	C	Maximum weaving length, L_{MAX}	6021 ft

Notes

a. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments".
b. For volumes that exceed the weaving segment capacity, the level of service is "F".

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-26 EB*
Agency or Company	*Atkins*	From/To	*1105-Mont SB Off to Mont SB On*
Date Performed	*4/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2013*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*4433*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*2*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.990*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*3*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*60.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*60.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1658*	pc/h/ln
S	*59.9*	mph
D = v_p / S	*27.7*	pc/mi/ln
LOS	*D*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-26 EB*
Agency or Company	*Atkins*	From/To	*1105-Mont SB Off to Mont SB On*
Date Performed	*4/25/2014*	Jurisdiction	
Analysis Time Period	*PM Peak*	Analysis Year	*2013*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*2954*	veh/h	Peak-Hour Factor, PHF	*0.90*	
AADT		veh/day	%Trucks and Buses, P_T	*4*	
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*	
Peak-Hr Direction Prop, D			General Terrain:	*Level*	
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*	

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.980*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*3*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*60.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*60.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1116*	pc/h/ln
S	*60.0*	mph
D = v_p / S	*18.6*	pc/mi/ln
LOS	*C*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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Navy Base ICTF

FREEWAY WEAVING WORKSHEET

General Information

Analyst	AJR
Agency/Company	Atkins
Date Performed	3/20/2014
Analysis Time Period	AM Peak

Site Information

Freeway/Dir of Travel	I-26 EB
Weaving Segment Location	1110 - Montague SB to Mont. NB
Analysis Year	2013

Project Description *Navy Base ICTF*

Inputs

Weaving configuration	One-Sided	Segment type	Freeway
Weaving number of lanes, N	4	Freeway minimum speed, S_{MIN}	15
Weaving segment length, L_S	470ft	Freeway maximum capacity, C_{IFL}	2300
Freeway free-flow speed, FFS	60 mph	Terrain type	Level

Conversions to pc/h Under Base Conditions

	V (veh/h)	PHF	Truck (%)	RV (%)	E_T	E_R	f_{HV}	f_p	v (pc/h)
V_{FF}	4010	0.90	2	0	1.5	1.2	0.990	1.00	4500
V_{RF}	282	0.90	10	0	1.5	1.2	0.952	1.00	329
V_{FR}	423	0.90	6	0	1.5	1.2	0.971	1.00	484
V_{RR}	0	0.90	0	0	1.5	1.2	1.000	1.00	0
V_{NW}	4500							V =	5313
V_W	813								
VR	0.153								

Configuration Characteristics

Minimum maneuver lanes, N_{WL}	2 lc	Minimum weaving lane changes, LC_{MIN}	813 lc/h
Interchange density, ID	1.0 int/mi	Weaving lane changes, LC_W	955 lc/h
Minimum RF lane changes, LC_{RF}	1 lc/pc	Non-weaving lane changes, LC_{NW}	411 lc/h
Minimum FR lane changes, LC_{FR}	1 lc/pc	Total lane changes, LC_{ALL}	1366 lc/h
Minimum RR lane changes, LC_{RR}	lc/pc	Non-weaving vehicle index, I_{NW}	212

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment flow rate, v	5313 pc/h	Weaving intensity factor, W	0.524
Weaving segment capacity, c_w	8020 veh/h	Weaving segment speed, S	47.2 mph
Weaving segment v/c ratio	0.656	Average weaving speed, S_W	44.5 mph
Weaving segment density, D	28.1 pc/mi/ln	Average non-weaving speed, S_{NW}	47.8 mph
Level of Service, LOS	D	Maximum weaving length, L_{MAX}	4062 ft

Notes

a. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments".
b. For volumes that exceed the weaving segment capacity, the level of service is "F".

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Navy Base ICTF

FREEWAY WEAVING WORKSHEET

General Information

Analyst	AJR
Agency/Company	Atkins
Date Performed	3/20/2014
Analysis Time Period	PM Peak

Site Information

Freeway/Dir of Travel	I-26 EB
Weaving Segment Location	1110 - Montague SB to Mont. NB
Analysis Year	2013

Project Description *Navy Base ICTF*

Inputs

Weaving configuration	One-Sided	Segment type	Freeway
Weaving number of lanes, N	4	Freeway minimum speed, S_{MIN}	15
Weaving segment length, L_S	470ft	Freeway maximum capacity, C_{IFL}	2300
Freeway free-flow speed, FFS	60 mph	Terrain type	Level

Conversions to pc/h Under Base Conditions

	V (veh/h)	PHF	Truck (%)	RV (%)	E_T	E_R	f_{HV}	f_p	v (pc/h)
V_{FF}	2740	0.90	4	0	1.5	1.2	0.980	1.00	3105
V_{RF}	354	0.90	4	0	1.5	1.2	0.980	1.00	401
V_{FR}	214	0.90	7	0	1.5	1.2	0.966	1.00	246
V_{RR}	0	0.90	0	0	1.5	1.2	1.000	1.00	0
V_{NW}	3105							V =	3752
V_W	647								
VR	0.172								

Configuration Characteristics

Minimum maneuver lanes, N_{WL}	2 lc	Minimum weaving lane changes, LC_{MIN}	647 lc/h
Interchange density, ID	1.0 int/mi	Weaving lane changes, LC_W	789 lc/h
Minimum RF lane changes, LC_{RF}	1 lc/pc	Non-weaving lane changes, LC_{NW}	124 lc/h
Minimum FR lane changes, LC_{FR}	1 lc/pc	Total lane changes, LC_{ALL}	913 lc/h
Minimum RR lane changes, LC_{RR}	lc/pc	Non-weaving vehicle index, I_{NW}	146

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment flow rate, v	3752 pc/h	Weaving intensity factor, W	0.382
Weaving segment capacity, c_w	7882 veh/h	Weaving segment speed, S	50.2 mph
Weaving segment v/c ratio	0.467	Average weaving speed, S_W	47.6 mph
Weaving segment density, D	18.7 pc/mi/ln	Average non-weaving speed, S_{NW}	50.8 mph
Level of Service, LOS	B	Maximum weaving length, L_{MAX}	4256 ft

Notes

a. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments".
b. For volumes that exceed the weaving segment capacity, the level of service is "F".

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-26 EB*
Agency or Company	*Atkins*	From/To	*1115-Mont NB Off to Mont NB On*
Date Performed	*4/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2013*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*4292*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*3*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.985*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*3*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*60.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*60.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1613*	pc/h/ln
S	*60.0*	mph
D = v_p / S	*26.9*	pc/mi/ln
LOS	*D*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-26 EB*
Agency or Company	*Atkins*	From/To	*1115-Mont NB Off to Mont NB On*
Date Performed	*4/25/2014*	Jurisdiction	
Analysis Time Period	*PM Peak*	Analysis Year	*2013*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*3094*	veh/h	Peak-Hour Factor, PHF	*0.90*	
AADT		veh/day	%Trucks and Buses, P_T	*4*	
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*	
Peak-Hr Direction Prop, D			General Terrain:	*Level*	
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*	

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.980*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*3*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*60.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*60.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1169*	pc/h/ln
S	*60.0*	mph
D = v_p / S	*19.5*	pc/mi/ln
LOS	*C*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-26 EB
Agency or Company	Atkins	Junction	1120 - EB On from Montague NB
Date Performed	4/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2013

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Number of Lanes, N: 3	☐ Yes ☐ On
☑ No ☐ Off	Acceleration Lane Length, L_A: 850	☑ No ☐ Off
L_{up} = ft	Deceleration Lane Length L_D:	L_{down} = ft
V_u = veh/h	Freeway Volume, V_F: 4292	V_D = veh/h
	Ramp Volume, V_R: 442	
	Freeway Free-Flow Speed, S_{FF}: 60.0	
	Ramp Free-Flow Speed, S_{FR}: 45.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	4292	0.90	Level	3	0	0.985	1.00	4840
Ramp	442	0.90	Level	7	0	0.966	1.00	508
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 0.601 using Equation (Exhibit 13-6)

V_{12} = 2910 pc/h

V_3 or V_{av34} 1930 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * $V_{12}/2$ ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	5348	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	3418	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = 26.6 (pc/mi/ln)

LOS = C (Exhibit 13-2)

Speed Determination

M_S = 0.363 (Exibit 13-11)

S_R= 53.5 mph (Exhibit 13-11)

S_0= 54.9 mph (Exhibit 13-11)

S = 54.0 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * $V_{12}/2$ ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-26 EB
Agency or Company	Atkins	Junction	1120 - EB On from Montague NB
Date Performed	4/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2013

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Number of Lanes, N: 3	☐ Yes ☐ On
☑ No ☐ Off	Acceleration Lane Length, L_A: 850	☑ No ☐ Off
L_{up} = ft	Deceleration Lane Length L_D:	L_{down} = ft
V_u = veh/h	Freeway Volume, V_F: 3094	V_D = veh/h
	Ramp Volume, V_R: 505	
	Freeway Free-Flow Speed, S_{FF}: 60.0	
	Ramp Free-Flow Speed, S_{FR}: 45.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	3094	0.90	Level	4	0	0.980	1.00	3507
Ramp	505	0.90	Level	2	0	0.990	1.00	567
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 0.601 using Equation (Exhibit 13-6)

V_{12} = 2109 pc/h

V_3 or V_{av34} 1398 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	4074	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	2676	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = 20.8 (pc/mi/ln)

LOS = C (Exhibit 13-2)

Speed Determination

M_S = 0.301 (Exibit 13-11)

S_R= 54.6 mph (Exhibit 13-11)

S_0= 56.8 mph (Exhibit 13-11)

S = 55.3 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-26 EB*
Agency or Company	*Atkins*	From/To	*1130 - Montague to Dorchester*
Date Performed	*4/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2013*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*4734*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*3*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.985*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*3*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*60.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*60.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1780*	pc/h/ln
S	*59.4*	mph
D = v_p / S	*30.0*	pc/mi/ln
LOS	*D*	

Design (N)

Design (N)

Design LOS	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h/ln
S	mph
D = v_p / S	pc/mi/ln
Required Number of Lanes, N	

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-26 EB*
Agency or Company	*Atkins*	From/To	*1130 - Montague to Dorchester*
Date Performed	*4/25/2014*	Jurisdiction	
Analysis Time Period	*PM Peak*	Analysis Year	*2013*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*3599*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*4*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.980*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*3*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*60.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*60.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1360*	pc/h/ln
S	*60.0*	mph
D = v_p / S	*22.7*	pc/mi/ln
LOS	*C*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-26 EB
Agency or Company	Atkins	Junction	1140-EB Off to Dorchester Rd
Date Performed	3/20/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2013

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Number of Lanes, N	3	Downstream Adj Ramp	
☐ Yes	☐ On	Acceleration Lane Length, L_A		☐ Yes	☐ On
☑ No	☐ Off	Deceleration Lane Length L_D	380	☑ No	☐ Off
L_{up} =	ft	Freeway Volume, V_F	4734	L_{down} =	ft
V_u =	veh/h	Ramp Volume, V_R	484	V_D =	veh/h
		Freeway Free-Flow Speed, S_{FF}	60.0		
		Ramp Free-Flow Speed, S_{FR}	45.0		

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	4734	0.90	Level	3	0	0.985	1.00	5339
Ramp	484	0.90	Level	12	0	0.943	1.00	570
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 0.600 using Equation (Exhibit 13-7)

V_{12} = 3433 pc/h

V_3 or V_{av34} 1906 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	5339	Exhibit 13-8	6900	No
$V_{FO} = V_F - V_R$	4769	Exhibit 13-8	6900	No
V_R	570	Exhibit 13-10	2100	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	3433	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = 30.4 (pc/mi/ln)

LOS = D (Exhibit 13-2)

Speed Determination

D_s = 0.349 (Exhibit 13-12)

S_R= 53.7 mph (Exhibit 13-12)

S_0= 62.3 mph (Exhibit 13-12)

S = 56.5 mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-26 EB
Agency or Company	Atkins	Junction	1140-EB Off to Dorchester Rd
Date Performed	3/20/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2013

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Number of Lanes, N	3	Downstream Adj Ramp	
☐ Yes	☐ On	Acceleration Lane Length, L_A		☐ Yes	☐ On
☑ No	☐ Off	Deceleration Lane Length L_D	380	☑ No	☐ Off
L_{up} =	ft	Freeway Volume, V_F	3599	L_{down} =	ft
		Ramp Volume, V_R	327		
V_u =	veh/h	Freeway Free-Flow Speed, S_{FF}	60.0	V_D =	veh/h
		Ramp Free-Flow Speed, S_{FR}	45.0		

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	3599	0.90	Level	4	0	0.980	1.00	4079
Ramp	327	0.90	Level	17	0	0.922	1.00	394
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 0.640 using Equation (Exhibit 13-7)

V_{12} = 2752 pc/h

V_3 or V_{av34} 1327 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	4079	Exhibit 13-8	6900	No
$V_{FO} = V_F - V_R$	3685	Exhibit 13-8	6900	No
V_R	394	Exhibit 13-10	2100	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	2752	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = 24.5 (pc/mi/ln)

LOS = C (Exhibit 13-2)

Speed Determination

D_s = 0.333 (Exhibit 13-12)

S_R= 54.0 mph (Exhibit 13-12)

S_0= 64.5 mph (Exhibit 13-12)

S = 57.0 mph (Exhibit 13-13)

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-26 EB*
Agency or Company	*Atkins*	From/To	*1145-Dorches Off to Dorches On*
Date Performed	*4/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2013*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*4250*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*2*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.990*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*3*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*60.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*60.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1590*	pc/h/ln
S	*60.0*	mph
D = v_p / S	*26.5*	pc/mi/ln
LOS	*D*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-26 EB*
Agency or Company	*Atkins*	From/To	*1145-Dorches Off to Dorches On*
Date Performed	*4/25/2014*	Jurisdiction	
Analysis Time Period	*PM Peak*	Analysis Year	*2013*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*3272*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*2*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.990*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*3*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*60.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*60.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1224*	pc/h/ln
S	*60.0*	mph
D = v_p / S	*20.4*	pc/mi/ln
LOS	*C*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-26 EB
Agency or Company	Atkins	Junction	1150 - EB On from Dorchester
Date Performed	4/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2013

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Freeway Number of Lanes, N: 3	☑ Yes ☐ On
☑ No ☐ Off	Ramp Number of Lanes, N: 1	☐ No ☑ Off
L_{up} = ft	Acceleration Lane Length, L_A: 560	L_{down} = 2100 ft
V_u = veh/h	Deceleration Lane Length L_D:	V_D = 755 veh/h
	Freeway Volume, V_F: 4250	
	Ramp Volume, V_R: 602	
	Freeway Free-Flow Speed, S_{FF}: 60.0	
	Ramp Free-Flow Speed, S_{FR}: 45.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	4250	0.90	Level	2	0	0.990	1.00	4769
Ramp	602	0.90	Level	10	0	0.952	1.00	702
UpStream								
DownStream	755	0.90	Level	10	0	0.952	1.00	881

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = 5197.03 (Equation 13-6 or 13-7)

P_{FM} = 0.659 using Equation (Exhibit 13-6)

V_{12} = 3143 pc/h

V_3 or V_{av34} 1626 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * $V_{12}/2$ ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	5471	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	3845	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = 31.6 (pc/mi/ln)

LOS = D (Exhibit 13-2)

Speed Determination

M_S = 0.453 (Exibit 13-11)

S_R= 51.8 mph (Exhibit 13-11)

S_0= 55.9 mph (Exhibit 13-11)

S = 53.0 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * $V_{12}/2$ ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-26 EB
Agency or Company	Atkins	Junction	1150 - EB On from Dorchester
Date Performed	4/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2013

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Freeway Number of Lanes, N: 3	☑ Yes ☐ On
☑ No ☐ Off	Ramp Number of Lanes, N: 1	☐ No ☑ Off
L_{up} = ft	Acceleration Lane Length, L_A: 560	L_{down} = 2100 ft
V_u = veh/h	Deceleration Lane Length L_D:	V_D = 1128 veh/h
	Freeway Volume, V_F: 3272	
	Ramp Volume, V_R: 477	
	Freeway Free-Flow Speed, S_{FF}: 60.0	
	Ramp Free-Flow Speed, S_{FR}: 45.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	3272	0.90	Level	2	0	0.990	1.00	3672
Ramp	477	0.90	Level	10	0	0.952	1.00	557
UpStream								
DownStream	1128	0.90	Level	7	0	0.966	1.00	1297

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = 7651.01 (Equation 13-6 or 13-7)

P_{FM} = 0.711 using Equation (Exhibit 13-6)

V_{12} = 2611 pc/h

V_3 or V_{av34} 1061 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * $V_{12}/2$ ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	4229	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	3168	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = 26.4 (pc/mi/ln)

LOS = C (Exhibit 13-2)

Speed Determination

M_S = 0.363 (Exibit 13-11)

S_R= 53.5 mph (Exhibit 13-11)

S_0= 58.0 mph (Exhibit 13-11)

S = 54.5 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * $V_{12}/2$ ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-26 EB
Agency or Company	Atkins	Junction	1160-EB Off to Cosgrove SB
Date Performed	3/20/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2013

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp

☑ Yes ☑ On

☐ No ☐ Off

L_{up} = 2100 ft

V_u = 602 veh/h

Freeway Number of Lanes, N	3
Ramp Number of Lanes, N	1
Acceleration Lane Length, L_A	
Deceleration Lane Length L_D	200
Freeway Volume, V_F	4852
Ramp Volume, V_R	755
Freeway Free-Flow Speed, S_{FF}	60.0
Ramp Free-Flow Speed, S_{FR}	45.0

Downstream Adj Ramp

☐ Yes ☐ On

☑ No ☐ Off

L_{down} = ft

V_D = veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	4852	0.90	Level	3	0	0.985	1.00	5472
Ramp	755	0.90	Level	10	0	0.952	1.00	881
UpStream	602	0.90	Level	10	0	0.952	1.00	702
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = 5404.16 (Equation 13-12 or 13-13)

P_{FD} = 0.583 using Equation (Exhibit 13-7)

V_{12} = 3556 pc/h

V_3 or V_{av34} 1916 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	5472	Exhibit 13-8	6900	No
$V_{FO} = V_F - V_R$	4591	Exhibit 13-8	6900	No
V_R	881	Exhibit 13-10	2100	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	3556	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = 33.0 (pc/mi/ln)

LOS = D (Exhibit 13-2)

Speed Determination

D_s = 0.377 (Exhibit 13-12)

S_R= 53.2 mph (Exhibit 13-12)

S_0= 62.2 mph (Exhibit 13-12)

S = 56.1 mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-26 EB
Agency or Company	Atkins	Junction	1160-EB Off to Cosgrove SB
Date Performed	3/20/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2013

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp

☑ Yes ☑ On

☐ No ☐ Off

L_{up} = 2100 ft

V_u = 477 veh/h

Freeway Number of Lanes, N	3
Ramp Number of Lanes, N	1
Acceleration Lane Length, L_A	
Deceleration Lane Length L_D	200
Freeway Volume, V_F	3749
Ramp Volume, V_R	1128
Freeway Free-Flow Speed, S_{FF}	60.0
Ramp Free-Flow Speed, S_{FR}	45.0

Downstream Adj Ramp

☐ Yes ☐ On

☑ No ☐ Off

L_{down} = ft

V_D = veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	3749	0.90	Level	3	0	0.985	1.00	4228
Ramp	1128	0.90	Level	7	0	0.966	1.00	1297
UpStream	477	0.90	Level	10	0	0.952	1.00	557
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = 7994.60 (Equation 13-12 or 13-13)

P_{FD} = 0.595 using Equation (Exhibit 13-7)

V_{12} = 3040 pc/h

V_3 or V_{av34} 1188 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	4228	Exhibit 13-8	6900	No
$V_{FO} = V_F - V_R$	2931	Exhibit 13-8	6900	No
V_R	1297	Exhibit 13-10	2100	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	3040	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = 28.6 (pc/mi/ln)

LOS = D (Exhibit 13-2)

Speed Determination

D_s = 0.415 (Exhibit 13-12)

S_R= 52.5 mph (Exhibit 13-12)

S_0= 65.1 mph (Exhibit 13-12)

S = 55.5 mph (Exhibit 13-13)

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-26 EB*
Agency or Company	*Atkins*	From/To	*1165-Cosg SB Off to Cosg SB On*
Date Performed	*4/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2013*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*4097*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*2*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.990*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*3*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*60.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*60.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1533*	pc/h/ln
S	*60.0*	mph
D = v_p / S	*25.5*	pc/mi/ln
LOS	*C*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-26 EB*
Agency or Company	*Atkins*	From/To	*1165-Cosg SB Off to Cosg SB On*
Date Performed	*4/25/2014*	Jurisdiction	
Analysis Time Period	*PM Peak*	Analysis Year	*2013*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*2621*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*2*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.990*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*3*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*60.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*60.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*980*	pc/h/ln
S	*60.0*	mph
D = v_p / S	*16.3*	pc/mi/ln
LOS	*B*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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Navy Base ICTF

FREEWAY WEAVING WORKSHEET

General Information

Analyst	AJR
Agency/Company	Atkins
Date Performed	3/20/2014
Analysis Time Period	AM Peak

Site Information

Freeway/Dir of Travel	I-26 EB
Weaving Segment Location	1170 - Cosgrove SB to Cos. NB
Analysis Year	2013

Project Description *Navy Base ICTF*

Inputs

Weaving configuration	One-Sided
Weaving number of lanes, N	4
Weaving segment length, L_S	600ft
Freeway free-flow speed, FFS	60 mph
Segment type	Freeway
Freeway minimum speed, S_{MIN}	15
Freeway maximum capacity, C_{IFL}	2300
Terrain type	Level

Conversions to pc/h Under Base Conditions

	V (veh/h)	PHF	Truck (%)	RV (%)	E_T	E_R	f_{HV}	f_p	v (pc/h)
V_{FF}	3831	0.90	2	0	1.5	1.2	0.990	1.00	4299
V_{RF}	345	0.90	11	0	1.5	1.2	0.948	1.00	404
V_{FR}	266	0.90	10	0	1.5	1.2	0.952	1.00	310
V_{RR}	0	0.90	0	0	1.5	1.2	1.000	1.00	0
V_{NW}	4299							V =	5013
V_W	714								
VR	0.142								

Configuration Characteristics

Minimum maneuver lanes, N_{WL}	2 lc	Minimum weaving lane changes, LC_{MIN}	714 lc/h
Interchange density, ID	1.0 int/mi	Weaving lane changes, LC_W	902 lc/h
Minimum RF lane changes, LC_{RF}	1 lc/pc	Non-weaving lane changes, LC_{NW}	440 lc/h
Minimum FR lane changes, LC_{FR}	1 lc/pc	Total lane changes, LC_{ALL}	1342 lc/h
Minimum RR lane changes, LC_{RR}	lc/pc	Non-weaving vehicle index, I_{NW}	258

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment flow rate, v	5013 pc/h	Weaving intensity factor, W	0.427
Weaving segment capacity, c_w	8091 veh/h	Weaving segment speed, S	48.5 mph
Weaving segment v/c ratio	0.613	Average weaving speed, S_W	46.5 mph
Weaving segment density, D	25.8 pc/mi/ln	Average non-weaving speed, S_{NW}	48.8 mph
Level of Service, LOS	C	Maximum weaving length, L_{MAX}	3956 ft

Notes

a. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments".
b. For volumes that exceed the weaving segment capacity, the level of service is "F".

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Navy Base ICTF

FREEWAY WEAVING WORKSHEET

General Information

Analyst	AJR
Agency/Company	Atkins
Date Performed	3/20/2014
Analysis Time Period	PM Peak

Site Information

Freeway/Dir of Travel	I-26 EB
Weaving Segment Location	1170 - Cosgrove SB to Cos. NB
Analysis Year	2013

Project Description *Navy Base ICTF*

Inputs

Weaving configuration	One-Sided
Weaving number of lanes, N	4
Weaving segment length, L_S	600ft
Freeway free-flow speed, FFS	60 mph
Segment type	Freeway
Freeway minimum speed, S_{MIN}	15
Freeway maximum capacity, C_{IFL}	2300
Terrain type	Level

Conversions to pc/h Under Base Conditions

	V (veh/h)	PHF	Truck (%)	RV (%)	E_T	E_R	f_{HV}	f_p	v (pc/h)
V_{FF}	2489	0.90	2	0	1.5	1.2	0.990	1.00	2793
V_{RF}	343	0.90	8	0	1.5	1.2	0.962	1.00	396
V_{FR}	132	0.90	13	0	1.5	1.2	0.939	1.00	156
V_{RR}	0	0.90	0	0	1.5	1.2	1.000	1.00	0
V_{NW}	2793							V =	3345
V_W	552								
VR	0.165								

Configuration Characteristics

Minimum maneuver lanes, N_{WL}	2 lc	Minimum weaving lane changes, LC_{MIN}	552 lc/h
Interchange density, ID	1.0 int/mi	Weaving lane changes, LC_W	740 lc/h
Minimum RF lane changes, LC_{RF}	1 lc/pc	Non-weaving lane changes, LC_{NW}	130 lc/h
Minimum FR lane changes, LC_{FR}	1 lc/pc	Total lane changes, LC_{ALL}	870 lc/h
Minimum RR lane changes, LC_{RR}	lc/pc	Non-weaving vehicle index, I_{NW}	168

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment flow rate, v	3345 pc/h	Weaving intensity factor, W	0.303
Weaving segment capacity, c_w	8024 veh/h	Weaving segment speed, S	51.6 mph
Weaving segment v/c ratio	0.413	Average weaving speed, S_W	49.5 mph
Weaving segment density, D	16.2 pc/mi/ln	Average non-weaving speed, S_{NW}	52.0 mph
Level of Service, LOS	B	Maximum weaving length, L_{MAX}	4182 ft

Notes

a. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments".
b. For volumes that exceed the weaving segment capacity, the level of service is "F".

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-26 EB*
Agency or Company	*Atkins*	From/To	*1175-Cosg NB Off to Cosg NB On*
Date Performed	*4/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2013*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*4176*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*2*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.990*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*3*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*60.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*60.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1562*	pc/h/ln
S	*60.0*	mph
D = v_p / S	*26.0*	pc/mi/ln
LOS	*D*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-26 EB*
Agency or Company	*Atkins*	From/To	*1175-Cosg NB Off to Cosg NB On*
Date Performed	*4/25/2014*	Jurisdiction	
Analysis Time Period	*PM Peak*	Analysis Year	*2013*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*2832*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*2*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.990*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*3*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*60.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*60.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1059*	pc/h/ln
S	*60.0*	mph
D = v_p / S	*17.6*	pc/mi/ln
LOS	*B*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-26 EB
Agency or Company	Atkins	Junction	1180 - EB On from Cosgrove NB
Date Performed	4/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2013

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Freeway Number of Lanes, N	3	Downstream Adj Ramp	
☐ Yes	☐ On	Ramp Number of Lanes, N	1	☐ Yes	☐ On
☑ No	☐ Off	Acceleration Lane Length, L_A	440	☑ No	☐ Off
L_{up} =	ft	Deceleration Lane Length L_D		L_{down} =	ft
V_u =	veh/h	Freeway Volume, V_F	4176	V_D =	veh/h
		Ramp Volume, V_R	816		
		Freeway Free-Flow Speed, S_{FF}	60.0		
		Ramp Free-Flow Speed, S_{FR}	45.0		

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	4176	0.90	Level	2	0	0.990	1.00	4686
Ramp	816	0.90	Level	14	0	0.935	1.00	970
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 0.590 using Equation (Exhibit 13-6)

V_{12} = 2764 pc/h

V_3 or V_{av34} 1922 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * $V_{12}/2$ ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	5656	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	3734	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = 31.4 (pc/mi/ln)

LOS = D (Exhibit 13-2)

Speed Determination

M_S = 0.445 (Exibit 13-11)

S_R= 52.0 mph (Exhibit 13-11)

S_0= 54.9 mph (Exhibit 13-11)

S = 52.9 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * $V_{12}/2$ ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-26 EB
Agency or Company	Atkins	Junction	1180 - EB On from Cosgrove NB
Date Performed	4/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2013

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Freeway Number of Lanes, N	3	Downstream Adj Ramp	
☐ Yes	☐ On	Ramp Number of Lanes, N	1	☐ Yes	☐ On
☑ No	☐ Off	Acceleration Lane Length, L_A	440	☑ No	☐ Off
L_{up} =	ft	Deceleration Lane Length L_D		L_{down} =	ft
V_u =	veh/h	Freeway Volume, V_F	2832	V_D =	veh/h
		Ramp Volume, V_R	434		
		Freeway Free-Flow Speed, S_{FF}	60.0		
		Ramp Free-Flow Speed, S_{FR}	45.0		

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	2832	0.90	Level	2	0	0.990	1.00	3178
Ramp	434	0.90	Level	16	0	0.926	1.00	521
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 0.590 using Equation (Exhibit 13-6)

V_{12} = 1874 pc/h

V_3 or V_{av34} 1304 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * $V_{12}/2$ ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	3699	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	2395	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = 21.2 (pc/mi/ln)

LOS = C (Exhibit 13-2)

Speed Determination

M_S = 0.324 (Exibit 13-11)

S_R= 54.2 mph (Exhibit 13-11)

S_0= 57.1 mph (Exhibit 13-11)

S = 55.2 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * $V_{12}/2$ ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-26 EB*
Agency or Company	*Atkins*	From/To	*1190 - Cosgrove to US-52*
Date Performed	*4/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2013*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*4992*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*4*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.980*

Speed Inputs			Calc Speed Adj and FFS		
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f_{LW}		mph
Number of Lanes, N	*3*		f_{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	*60.0*	mph	FFS	*60.0*	mph
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures			Design (N)	
Operational (LOS)			Design (N)	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1886*	pc/h/ln	Design LOS	
			v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h/ln
S	*58.5*	mph	S	mph
D = v_p / S	*32.2*	pc/mi/ln	D = v_p / S	pc/mi/ln
LOS	*D*		Required Number of Lanes, N	

Glossary		Factor Location	
N - Number of lanes	S - Speed	E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
V - Hourly volume	D - Density	E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 11-18	TRD - Page 11-11
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 11-2, 11-3	
DDHV - Directional design hour volume			

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-26 EB*
Agency or Company	*Atkins*	From/To	*1190 - Cosgrove to US-52*
Date Performed	*4/25/2014*	Jurisdiction	
Analysis Time Period	*PM Peak*	Analysis Year	*2013*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*3266*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*4*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.980*

Speed Inputs			Calc Speed Adj and FFS		
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f_{LW}		mph
Number of Lanes, N	*3*		f_{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	*60.0*	mph	FFS	*60.0*	mph
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures			Design (N)	
Operational (LOS)			Design (N)	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1234*	pc/h/ln	Design LOS	
			v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h/ln
S	*60.0*	mph	S	mph
D = v_p / S	*20.6*	pc/mi/ln	D = v_p / S	pc/mi/ln
LOS	*C*		Required Number of Lanes, N	

Glossary		Factor Location	
N - Number of lanes	S - Speed	E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
V - Hourly volume	D - Density	E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 11-18	TRD - Page 11-11
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 11-2, 11-3	
DDHV - Directional design hour volume			

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-26 EB
Agency or Company	Atkins	Junction	1200-EB Off to US-52
Date Performed	3/20/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2013

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Freeway Number of Lanes, N: 3	☐ Yes ☐ On
☑ No ☐ Off	Ramp Number of Lanes, N: 1	☑ No ☐ Off
L_{up} = ft	Acceleration Lane Length, L_A	L_{down} = ft
V_u = veh/h	Deceleration Lane Length L_D: 350	V_D = veh/h
	Freeway Volume, V_F: 4992	
	Ramp Volume, V_R: 244	
	Freeway Free-Flow Speed, S_{FF}: 60.0	
	Ramp Free-Flow Speed, S_{FR}: 45.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	4992	0.90	Level	4	0	0.980	1.00	5658
Ramp	244	0.90	Level	26	0	0.885	1.00	306
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 0.604 using Equation (Exhibit 13-7)

V_{12} = 3541 pc/h

V_3 or V_{av34} 2117 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	5658	Exhibit 13-8	6900	No
$V_{FO} = V_F - V_R$	5352	Exhibit 13-8	6900	No
V_R	306	Exhibit 13-10	2100	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	3541	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = 31.6 (pc/mi/ln)

LOS = D (Exhibit 13-2)

Speed Determination

D_s = 0.326 (Exhibit 13-12)

S_R= 54.1 mph (Exhibit 13-12)

S_0= 61.5 mph (Exhibit 13-12)

S = 56.7 mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-26 EB
Agency or Company	Atkins	Junction	1200-EB Off to US-52
Date Performed	3/20/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2013

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On		☐ Yes ☐ On
☑ No ☐ Off		☑ No ☐ Off
L_{up} = ft		L_{down} = ft
V_u = veh/h		V_D = veh/h

Freeway Number of Lanes, N	3
Ramp Number of Lanes, N	1
Acceleration Lane Length, L_A	
Deceleration Lane Length L_D	350
Freeway Volume, V_F	3266
Ramp Volume, V_R	274
Freeway Free-Flow Speed, S_{FF}	60.0
Ramp Free-Flow Speed, S_{FR}	45.0

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	3266	0.90	Level	4	0	0.980	1.00	3701
Ramp	274	0.90	Level	20	0	0.909	1.00	335
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 0.652 using Equation (Exhibit 13-7)

V_{12} = 2530 pc/h

V_3 or V_{av34} 1171 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	3701	Exhibit 13-8	6900	No
$V_{FO} = V_F - V_R$	3366	Exhibit 13-8	6900	No
V_R	335	Exhibit 13-10	2100	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	2530	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = 22.9 (pc/mi/ln)

LOS = C (Exhibit 13-2)

Speed Determination

D_s = 0.328 (Exhibit 13-12)

S_R= 54.1 mph (Exhibit 13-12)

S_0= 65.2 mph (Exhibit 13-12)

S = 57.2 mph (Exhibit 13-13)

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-26 EB*
Agency or Company	*Atkins*	From/To	*1205 - US52 to Spruill*
Date Performed	*4/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2013*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*4748*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*3*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.985*

Speed Inputs			Calc Speed Adj and FFS		
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f_{LW}		mph
Number of Lanes, N	*3*		f_{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	*60.0*	mph	FFS	*60.0*	mph
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures			Design (N)	
Operational (LOS)			Design (N)	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1785*	pc/h/ln	Design LOS	
			v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h/ln
S	*59.4*	mph	S	mph
D = v_p / S	*30.1*	pc/mi/ln	D = v_p / S	pc/mi/ln
LOS	*D*		Required Number of Lanes, N	

Glossary		Factor Location	
N - Number of lanes	S - Speed	E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
V - Hourly volume	D - Density	E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 11-18	TRD - Page 11-11
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 11-2, 11-3	
DDHV - Directional design hour volume			

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-26 EB*
Agency or Company	*Atkins*	From/To	*1205 - US52 to Spruill*
Date Performed	*4/25/2014*	Jurisdiction	
Analysis Time Period	*PM Peak*	Analysis Year	*2013*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*2992*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*2*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.990*

Speed Inputs			Calc Speed Adj and FFS		
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f_{LW}		mph
Number of Lanes, N	*3*		f_{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	*60.0*	mph	FFS	*60.0*	mph
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures			Design (N)	
Operational (LOS)			Design (N)	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1119*	pc/h/ln	Design LOS	
			v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h/ln
S	*60.0*	mph	S	mph
D = v_p / S	*18.6*	pc/mi/ln	D = v_p / S	pc/mi/ln
LOS	*C*		Required Number of Lanes, N	

Glossary		Factor Location	
N - Number of lanes	S - Speed	E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
V - Hourly volume	D - Density	E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 11-18	TRD - Page 11-11
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 11-2, 11-3	
DDHV - Directional design hour volume			

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-26 EB
Agency or Company	Atkins	Junction	1210 - EB On from Spruill
Date Performed	4/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2013

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Number of Lanes, N: 3	☐ Yes ☐ On
☑ No ☐ Off	Acceleration Lane Length, L_A: 950	☑ No ☐ Off
L_{up} = ft	Deceleration Lane Length L_D:	L_{down} = ft
V_u = veh/h	Freeway Volume, V_F: 4748	V_D = veh/h
	Ramp Volume, V_R: 205	
	Freeway Free-Flow Speed, S_{FF}: 60.0	
	Ramp Free-Flow Speed, S_{FR}: 45.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	4748	0.90	Level	3	0	0.985	1.00	5355
Ramp	205	0.90	Level	22	0	0.901	1.00	253
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 0.604 using Equation (Exhibit 13-6)

V_{12} = 3235 pc/h

V_3 or V_{av34} 2120 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	5608	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	3488	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = 26.6 (pc/mi/ln)

LOS = C (Exhibit 13-2)

Speed Determination

M_S = 0.363 (Exibit 13-11)

S_R= 53.5 mph (Exhibit 13-11)

S_0= 54.2 mph (Exhibit 13-11)

S = 53.7 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-26 EB
Agency or Company	Atkins	Junction	1210 - EB On from Spruill
Date Performed	4/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2013

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Number of Lanes, N: 3	☐ Yes ☐ On
☑ No ☐ Off	Acceleration Lane Length, L_A: 950	☑ No ☐ Off
L_{up} = ft	Deceleration Lane Length L_D:	L_{down} = ft
V_u = veh/h	Freeway Volume, V_F: 2992	V_D = veh/h
	Ramp Volume, V_R: 406	
	Freeway Free-Flow Speed, S_{FF}: 60.0	
	Ramp Free-Flow Speed, S_{FR}: 45.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	2992	0.90	Level	2	0	0.990	1.00	3358
Ramp	406	0.90	Level	10	0	0.952	1.00	474
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 0.604 using Equation (Exhibit 13-6)

V_{12} = 2029 pc/h

V_3 or V_{av34} 1329 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	3832	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	2503	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = 18.8 (pc/mi/ln)

LOS = B (Exhibit 13-2)

Speed Determination

M_S = 0.283 (Exibit 13-11)

S_R= 54.9 mph (Exhibit 13-11)

S_0= 57.0 mph (Exhibit 13-11)

S = 55.6 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-26 EB*
Agency or Company	*Atkins*	From/To	*1220 - Spruill to Heriot*
Date Performed	*4/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2013*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*4953*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*4*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.980*

Speed Inputs			Calc Speed Adj and FFS		
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f_{LW}		mph
Number of Lanes, N	*3*		f_{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	*60.0*	mph	FFS	*60.0*	mph
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures			Design (N)	
Operational (LOS)			Design (N)	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1871*	pc/h/ln	Design LOS	
			v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h/ln
S	*58.7*	mph	S	mph
D = v_p / S	*31.9*	pc/mi/ln	D = v_p / S	pc/mi/ln
LOS	*D*		Required Number of Lanes, N	

Glossary		Factor Location	
N - Number of lanes	S - Speed	E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
V - Hourly volume	D - Density	E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 11-18	TRD - Page 11-11
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 11-2, 11-3	
DDHV - Directional design hour volume			

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-26 EB*
Agency or Company	*Atkins*	From/To	*1220 - Spruill to Heriot*
Date Performed	*4/25/2014*	Jurisdiction	
Analysis Time Period	*PM Peak*	Analysis Year	*2013*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*3398*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*3*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.985*

Speed Inputs			Calc Speed Adj and FFS		
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f_{LW}		mph
Number of Lanes, N	*3*		f_{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	*60.0*	mph	FFS	*60.0*	mph
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures			Design (N)	
Operational (LOS)			Design (N)	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1277*	pc/h/ln	Design LOS	
			v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h/ln
S	*60.0*	mph	S	mph
D = v_p / S	*21.3*	pc/mi/ln	D = v_p / S	pc/mi/ln
LOS	*C*		Required Number of Lanes, N	

Glossary		Factor Location	
N - Number of lanes	S - Speed	E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
V - Hourly volume	D - Density	E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 11-18	TRD - Page 11-11
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 11-2, 11-3	
DDHV - Directional design hour volume			

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-26 EB
Agency or Company	Atkins	Junction	1230-EB Off to Heriot St
Date Performed	3/20/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2013

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp

☐ Yes ☐ On

☑ No ☐ Off

L_{up} = ft

V_u = veh/h

Freeway Number of Lanes, N	3
Ramp Number of Lanes, N	1
Acceleration Lane Length, L_A	
Deceleration Lane Length L_D	200
Freeway Volume, V_F	4953
Ramp Volume, V_R	625
Freeway Free-Flow Speed, S_{FF}	55.0
Ramp Free-Flow Speed, S_{FR}	45.0

Downstream Adj Ramp

☑ Yes ☐ On

☐ No ☑ Off

L_{down} = 1400 ft

V_D = 729 veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	4953	0.90	Level	4	0	0.980	1.00	5613
Ramp	625	0.90	Level	4	0	0.980	1.00	708
UpStream								
DownStream	729	0.90	Level	9	0	0.957	1.00	846

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = 1194.05 (Equation 13-12 or 13-13)

P_{FD} = 0.587 using Equation (Exhibit 13-7)

V_{12} = 3588 pc/h

V_3 or V_{av34} 2025 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	5613	Exhibit 13-8	6750	No
$V_{FO} = V_F - V_R$	4905	Exhibit 13-8	6750	No
V_R	708	Exhibit 13-10	2100	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	3588	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = 33.3 (pc/mi/ln)

LOS = D (Exhibit 13-2)

Speed Determination

D_s = 0.362 (Exhibit 13-12)

S_R= 50.3 mph (Exhibit 13-12)

S_0= 56.3 mph (Exhibit 13-12)

S = 52.3 mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-26 EB
Agency or Company	Atkins	Junction	1230-EB Off to Heriot St
Date Performed	3/20/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2013

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp

☐ Yes ☐ On

☑ No ☐ Off

L_{up} = ft

V_u = veh/h

Freeway Number of Lanes, N	3
Ramp Number of Lanes, N	1
Acceleration Lane Length, L_A	
Deceleration Lane Length L_D	200
Freeway Volume, V_F	3398
Ramp Volume, V_R	442
Freeway Free-Flow Speed, S_{FF}	55.0
Ramp Free-Flow Speed, S_{FR}	45.0

Downstream Adj Ramp

☑ Yes ☐ On

☐ No ☑ Off

L_{down} = 1400 ft

V_D = 333 veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	3398	0.90	Level	3	0	0.985	1.00	3832
Ramp	442	0.90	Level	2	0	0.990	1.00	496
UpStream								
DownStream	333	0.90	Level	4	0	0.980	1.00	377

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = 446.72 (Equation 13-12 or 13-13)

P_{FD} = 0.641 using Equation (Exhibit 13-7)

V_{12} = 2636 pc/h

V_3 or V_{av34} 1196 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	3832	Exhibit 13-8	6750	No
$V_{FO} = V_F - V_R$	3336	Exhibit 13-8	6750	No
V_R	496	Exhibit 13-10	2100	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	2636	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = 25.1 (pc/mi/ln)

LOS = C (Exhibit 13-2)

Speed Determination

D_s = 0.343 (Exhibit 13-12)

S_R= 50.5 mph (Exhibit 13-12)

S_0= 59.6 mph (Exhibit 13-12)

S = 53.1 mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-26 EB
Agency or Company	Atkins	Junction	1240-EB Off to Mt. Pleasant St
Date Performed	3/20/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2013

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Number of Lanes, N	3	Downstream Adj Ramp	
☐ Yes	☐ On	Acceleration Lane Length, L_A		☐ Yes	☐ On
☑ No	☐ Off	Deceleration Lane Length L_D	175	☑ No	☐ Off
L_{up} =	ft	Freeway Volume, V_F	4328	L_{down} =	ft
V_u =	veh/h	Ramp Volume, V_R	729	V_D =	veh/h
		Freeway Free-Flow Speed, S_{FF}	55.0		
		Ramp Free-Flow Speed, S_{FR}	45.0		

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	4328	0.90	Level	3	0	0.985	1.00	4881
Ramp	729	0.90	Level	9	0	0.957	1.00	846
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 0.599 using Equation (Exhibit 13-7)

V_{12} = 3263 pc/h

V_3 or V_{av34} 1618 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	4881	Exhibit 13-8	6750	No
$V_{FO} = V_F - V_R$	4035	Exhibit 13-8	6750	No
V_R	846	Exhibit 13-10	2100	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	3263	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = 30.7 (pc/mi/ln)

LOS = D (Exhibit 13-2)

Speed Determination

D_s = 0.374 (Exhibit 13-12)

S_R= 50.1 mph (Exhibit 13-12)

S_0= 57.9 mph (Exhibit 13-12)

S = 52.5 mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-26 EB
Agency or Company	Atkins	Junction	1240-EB Off to Mt. Pleasant St
Date Performed	3/20/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2013

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Number of Lanes, N	3	Downstream Adj Ramp	
☐ Yes	☐ On	Acceleration Lane Length, L_A		☐ Yes	☐ On
☑ No	☐ Off	Deceleration Lane Length L_D	175	☑ No	☐ Off
L_{up} =	ft	Freeway Volume, V_F	2956	L_{down} =	ft
V_u =	veh/h	Ramp Volume, V_R	333	V_D =	veh/h
		Freeway Free-Flow Speed, S_{FF}	55.0		
		Ramp Free-Flow Speed, S_{FR}	45.0		

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	2956	0.90	Level	3	0	0.985	1.00	3334
Ramp	333	0.90	Level	4	0	0.980	1.00	377
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 0.659 using Equation (Exhibit 13-7)

V_{12} = 2327 pc/h

V_3 or V_{av34} 1007 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	3334	Exhibit 13-8	6750	No
$V_{FO} = V_F - V_R$	2957	Exhibit 13-8	6750	No
V_R	377	Exhibit 13-10	2100	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	2327	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = 22.7 (pc/mi/ln)

LOS = C (Exhibit 13-2)

Speed Determination

D_s = 0.332 (Exhibit 13-12)

S_R= 50.7 mph (Exhibit 13-12)

S_0= 60.3 mph (Exhibit 13-12)

S = 53.3 mph (Exhibit 13-13)

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FREEWAY RAMP ADD OR DROP LANE ANALYSIS

ATKINS

General Information

Date Performed:	3/20/2014	Freeway/Direction	I-26 EB
Analysis Year	2013	Junction	EB Off to US-17 NB
Analysis Time Period:	AM Peak	Segment ID	1250
Project Description:	Navy Base ICTF		

Inputs

	Freeway Upstream of Ramp	Freeway Downstream of Ramp	Ramp
Number of Lanes, N	3	2	1
Free-Flow Speed, FFS (mph)	55	55	55
Volume, V (veh/h)	3,599	2,509	1,090
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	2%	3%	2%
%RVs, P_R	0%	0%	0%

Performance Measures

	Freeway Upstream Ramp	Freeway Downstream Ramp	Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.99	0.99	0.99
Demand Flow Rate, v_p (pc/h/ln)	1,346	1,415	1,223
Capacity Flow Rate, c (pc/h/ln)	2,250	2,250	2,200
v/c ratio	0.60	0.63	0.56
Density, D_{MD} (pc/mi/ln)	23.6	24.8	21.4
LOS	C	C	C

Formulas and Reference Material

$$f_{HV} = \frac{1}{1+P_T(E_T-1)+P_R(E_R-1)}$$ HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P}$$ HCM 2010, Equation 11-2

$$D_{MD} = \frac{0.0175*v_f}{N}$$ HCM 2010, Equation 13-26

Basic Freeway Segments Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
75	2,400
70	2,400
65	2,350
60	2,300
55	2,250

Source: HCM 2010, Exhibit 11-17

Ramp Roadways Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

Diverge LOS Thresholds

LOS	Density (pc/mi/ln)
A	≤10
B	>10-20
C	>20-28
D	>28-35
E	>35
F	v/c > 1

Source: HCM 2010, Exhibit 13-2

FREEWAY RAMP ADD OR DROP LANE ANALYSIS

ATKINS

General Information

Date Performed:	3/20/2014	Freeway/Direction	I-26 EB
Analysis Year	2013	Junction	EB Off to US-17 NB
Analysis Time Period:	PM Peak	Segment ID	1250
Project Description:	Navy Base ICTF		

Inputs

	Freeway Upstream of Ramp	Freeway Downstream of Ramp	Ramp
Number of Lanes, N	3	2	1
Free-Flow Speed, FFS (mph)	55	55	55
Volume, V (veh/h)	2,623	2,059	564
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	3%	4%	2%
%RVs, P_R	0%	0%	0%

Performance Measures

	Freeway Upstream Ramp	Freeway Downstream Ramp	Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.99	0.98	0.99
Demand Flow Rate, v_p (pc/h/ln)	986	1,167	633
Capacity Flow Rate, c (pc/h/ln)	2,250	2,250	2,200
v/c ratio	0.44	0.52	0.29
Density, D_{MD} (pc/mi/ln)	17.3	20.4	11.1
LOS	B	C	B

Formulas and Reference Material

$$f_{HV} = \frac{1}{1+P_T(E_T-1)+P_R(E_R-1)}$$ HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P}$$ HCM 2010, Equation 11-2

$$D_{MD} = \frac{0.0175*v_f}{N}$$ HCM 2010, Equation 13-26

Basic Freeway Segments Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
75	2,400
70	2,400
65	2,350
60	2,300
55	2,250

Source: HCM 2010, Exhibit 11-17

Ramp Roadways Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

Diverge LOS Thresholds

LOS	Density (pc/mi/ln)
A	≤10
B	>10-20
C	>20-28
D	>28-35
E	>35
F	v/c > 1

Source: HCM 2010, Exhibit 13-2

BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-26 EB*
Agency or Company	*Atkins*	From/To	*1260 - US17 NB to Cypress St*
Date Performed	*4/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2013*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*2509*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*3*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.985*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*55.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*55.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1415*	pc/h/ln
S	*55.0*	mph
D = v_p / S	*25.7*	pc/mi/ln
LOS	*C*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-26 EB*
Agency or Company	*Atkins*	From/To	*1260 - US17 NB to Cypress St*
Date Performed	*4/25/2014*	Jurisdiction	
Analysis Time Period	*PM Peak*	Analysis Year	*2013*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*2059*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*4*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.980*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*55.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*55.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1167*	pc/h/ln
S	*55.0*	mph
D = v_p / S	*21.2*	pc/mi/ln
LOS	*C*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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FREEWAY RAMP ADD OR DROP LANE ANALYSIS

ATKINS

General Information

Date Performed:	3/20/2014	Freeway/Direction	I-26 EB
Analysis Year	2013	Junction	EB On from Cypress St
Analysis Time Period:	AM Peak	Segment ID	1270
Project Description:	Navy Base ICTF		

Inputs

	Freeway Upstream of Ramp	Freeway Downstream of Ramp	Ramp
Number of Lanes, N	2	3	1
Free-Flow Speed, FFS (mph)	55	55	45
Volume, V (veh/h)	2,509	2,582	73
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	3%	3%	19%
%RVs, P_R	0%	0%	0%

Performance Measures

	Freeway Upstream Ramp	Freeway Downstream Ramp	Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.99	0.99	0.91
Demand Flow Rate, v_p (pc/h/ln)	1,415	971	89
Capacity Flow Rate, c (pc/h/ln)	2,250	2,250	2,100
v/c ratio	0.63	0.43	0.04
Density, D_{MD} (pc/mi/ln)	24.8	17.0	1.6
LOS	C	B	A

Formulas and Reference Material

$$f_{HV} = \frac{1}{1+P_T(E_T-1)+P_R(E_R-1)}$$ HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P}$$ HCM 2010, Equation 11-2

$$D_{MD} = \frac{0.0175*v_f}{N}$$ HCM 2010, Equation 13-26

Basic Freeway Segments Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
75	2,400
70	2,400
65	2,350
60	2,300
55	2,250

Source: HCM 2010, Exhibit 11-17

Ramp Roadways Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

Diverge LOS Thresholds

LOS	Density (pc/mi/ln)
A	≤10
B	>10-20
C	>20-28
D	>28-35
E	>35
F	v/c > 1

Source: HCM 2010, Exhibit 13-2

FREEWAY RAMP ADD OR DROP LANE ANALYSIS

ATKINS

General Information

Date Performed:	3/20/2014	Freeway/Direction	I-26 EB
Analysis Year	2013	Junction	EB On from Cypress St
Analysis Time Period:	PM Peak	Segment ID	1270
Project Description:	Navy Base ICTF		

Inputs

	Freeway Upstream of Ramp	Freeway Downstream of Ramp	Ramp
Number of Lanes, N	2	3	1
Free-Flow Speed, FFS (mph)	55	55	45
Volume, V (veh/h)	2,059	2,182	123
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	4%	4%	15%
%RVs, P_R	0%	0%	0%

Performance Measures

	Freeway Upstream Ramp	Freeway Downstream Ramp	Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.98	0.98	0.93
Demand Flow Rate, v_p (pc/h/ln)	1,167	824	147
Capacity Flow Rate, c (pc/h/ln)	2,250	2,250	2,100
v/c ratio	0.52	0.37	0.07
Density, D_{MD} (pc/mi/ln)	20.4	14.4	2.6
LOS	C	B	A

Formulas and Reference Material

$$f_{HV} = \frac{1}{1+P_T(E_T-1)+P_R(E_R-1)}$$ HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P}$$ HCM 2010, Equation 11-2

$$D_{MD} = \frac{0.0175*v_f}{N}$$ HCM 2010, Equation 13-26

Basic Freeway Segments Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
75	2,400
70	2,400
65	2,350
60	2,300
55	2,250

Source: HCM 2010, Exhibit 11-17

Ramp Roadways Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

Diverge LOS Thresholds

LOS	Density (pc/mi/ln)
A	≤10
B	>10-20
C	>20-28
D	>28-35
E	>35
F	v/c > 1

Source: HCM 2010, Exhibit 13-2

BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-26 EB*
Agency or Company	*Atkins*	From/To	*1280 - East Of Cypress*
Date Performed	*4/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2013*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*2582*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*3*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.985*

Speed Inputs			Calc Speed Adj and FFS		
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f_{LW}		mph
Number of Lanes, N	*3*		f_{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	*55.0*	mph	FFS	*55.0*	mph
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures			Design (N)	
Operational (LOS)			Design (N)	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*971*	pc/h/ln	Design LOS	
S	*55.0*	mph	v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h/ln
D = v_p / S	*17.7*	pc/mi/ln	S	mph
LOS	*B*		D = v_p / S	pc/mi/ln
			Required Number of Lanes, N	

Glossary		Factor Location	
N - Number of lanes	S - Speed	E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
V - Hourly volume	D - Density	E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 11-18	TRD - Page 11-11
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 11-2, 11-3	
DDHV - Directional design hour volume			

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-26 EB*
Agency or Company	*Atkins*	From/To	*1280 - East Of Cypress*
Date Performed	*4/25/2014*	Jurisdiction	
Analysis Time Period	*PM Peak*	Analysis Year	*2013*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*2182*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*4*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.980*

Speed Inputs			Calc Speed Adj and FFS		
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f_{LW}		mph
Number of Lanes, N	*3*		f_{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	*55.0*	mph	FFS	*55.0*	mph
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures			Design (N)	
Operational (LOS)			Design (N)	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*824*	pc/h/ln	Design LOS	
S	*55.0*	mph	v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h/ln
D = v_p / S	*15.0*	pc/mi/ln	S	mph
LOS	*B*		D = v_p / S	pc/mi/ln
			Required Number of Lanes, N	

Glossary		Factor Location	
N - Number of lanes	S - Speed	E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
V - Hourly volume	D - Density	E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 11-18	TRD - Page 11-11
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 11-2, 11-3	
DDHV - Directional design hour volume			

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FREEWAY RAMP ADD OR DROP LANE ANALYSIS

ATKINS

General Information

Date Performed:	3/20/2014	Freeway/Direction	I-26 WB
Analysis Year	2013	Junction	WB Off to US-17 NB
Analysis Time Period:	AM Peak	Segment ID	2010
Project Description:	Navy Base ICTF		

Inputs

	Freeway Upstream of Ramp	Freeway Downstream of Ramp	Ramp
Number of Lanes, N	4	3	2
Free-Flow Speed, FFS (mph)	55	55	55
Volume, V (veh/h)	3,263	1,537	1,726
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	2%	2%	2%
%RVs, P_R	0%	0%	0%

Performance Measures

	Freeway Upstream Ramp	Freeway Downstream Ramp	Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.99	0.99	0.99
Demand Flow Rate, v_p (pc/h/ln)	915	575	968
Capacity Flow Rate, c (pc/h/ln)	2,250	2,250	2,200
v/c ratio	0.41	0.26	0.44
Density, D_{MD} (pc/mi/ln)	16.0	10.1	16.9
LOS	B	B	B

Formulas and Reference Material

$$f_{HV} = \frac{1}{1+P_T(E_T-1)+P_R(E_R-1)}$$

HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P}$$

HCM 2010, Equation 11-2

$$D_{MD} = \frac{0.0175*v_f}{N}$$

HCM 2010, Equation 13-26

Basic Freeway Segments Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
75	2,400
70	2,400
65	2,350
60	2,300
55	2,250

Source: HCM 2010, Exhibit 11-17

Ramp Roadways Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

Diverge LOS Thresholds

LOS	Density (pc/mi/ln)
A	≤10
B	>10-20
C	>20-28
D	>28-35
E	>35
F	v/c > 1

Source: HCM 2010, Exhibit 13-2

FREEWAY RAMP ADD OR DROP LANE ANALYSIS

ATKINS

General Information

Date Performed:	3/20/2014	Freeway/Direction	I-26 WB
Analysis Year	2013	Junction	WB Off to US-17 NB
Analysis Time Period:	PM Peak	Segment ID	2010
Project Description:	Navy Base ICTF		

Inputs

	Freeway Upstream of Ramp	Freeway Downstream of Ramp	Ramp
Number of Lanes, N	4	3	2
Free-Flow Speed, FFS (mph)	55	55	55
Volume, V (veh/h)	4,087	2,112	1,975
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	2%	2%	2%
%RVs, P_R	0%	0%	0%

Performance Measures

	Freeway Upstream Ramp	Freeway Downstream Ramp	Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.99	0.99	0.99
Demand Flow Rate, v_p (pc/h/ln)	1,147	790	1,108
Capacity Flow Rate, c (pc/h/ln)	2,250	2,250	2,200
v/c ratio	0.51	0.35	0.50
Density, D_{MD} (pc/mi/ln)	20.1	13.8	19.4
LOS	C	B	B

Formulas and Reference Material

$$f_{HV} = \frac{1}{1+P_T(E_T-1)+P_R(E_R-1)}$$ HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P}$$ HCM 2010, Equation 11-2

$$D_{MD} = \frac{0.0175*v_f}{N}$$ HCM 2010, Equation 13-26

Basic Freeway Segments Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
75	2,400
70	2,400
65	2,350
60	2,300
55	2,250

Source: HCM 2010, Exhibit 11-17

Ramp Roadways Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

Diverge LOS Thresholds

LOS	Density (pc/mi/ln)
A	≤10
B	>10-20
C	>20-28
D	>28-35
E	>35
F	v/c > 1

Source: HCM 2010, Exhibit 13-2

FREEWAY RAMP ADD OR DROP LANE ANALYSIS

ATKINS

General Information

Date Performed:	3/20/2014	Freeway/Direction	I-26 WB
Analysis Year	2013	Junction	WB Off to Romney St
Analysis Time Period:	AM Peak	Segment ID	2020
Project Description:	Navy Base ICTF		

Inputs

	Freeway Upstream of Ramp	Freeway Downstream of Ramp	Ramp
Number of Lanes, N	3	2	1
Free-Flow Speed, FFS (mph)	55	55	45
Volume, V (veh/h)	1,537	1,338	199
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	2%	2%	5%
%RVs, P_R	0%	0%	0%

Performance Measures

	Freeway Upstream Ramp	Freeway Downstream Ramp	Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.99	0.99	0.98
Demand Flow Rate, v_p (pc/h/ln)	575	751	227
Capacity Flow Rate, c (pc/h/ln)	2,250	2,250	2,100
v/c ratio	0.26	0.33	0.11
Density, D_{MD} (pc/mi/ln)	10.1	13.1	4.0
LOS	B	B	A

Formulas and Reference Material

$$f_{HV} = \frac{1}{1+P_T(E_T-1)+P_R(E_R-1)}$$ HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P}$$ HCM 2010, Equation 11-2

$$D_{MD} = \frac{0.0175*v_f}{N}$$ HCM 2010, Equation 13-26

Basic Freeway Segments Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
75	2,400
70	2,400
65	2,350
60	2,300
55	2,250

Source: HCM 2010, Exhibit 11-17

Ramp Roadways Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

Diverge LOS Thresholds

LOS	Density (pc/mi/ln)
A	≤10
B	>10-20
C	>20-28
D	>28-35
E	>35
F	v/c > 1

Source: HCM 2010, Exhibit 13-2

FREEWAY RAMP ADD OR DROP LANE ANALYSIS

ATKINS

General Information

Date Performed:	3/20/2014	Freeway/Direction	I-26 WB
Analysis Year	2013	Junction	WB Off to Romney St
Analysis Time Period:	PM Peak	Segment ID	2020
Project Description:	Navy Base ICTF		

Inputs

	Freeway Upstream of Ramp	Freeway Downstream of Ramp	Ramp
Number of Lanes, N	3	2	1
Free-Flow Speed, FFS (mph)	55	55	45
Volume, V (veh/h)	2,112	1,982	130
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	2%	2%	6%
%RVs, P_R	0%	0%	0%

Performance Measures

	Freeway Upstream Ramp	Freeway Downstream Ramp	Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.99	0.99	0.97
Demand Flow Rate, v_p (pc/h/ln)	790	1,112	149
Capacity Flow Rate, c (pc/h/ln)	2,250	2,250	2,100
v/c ratio	0.35	0.49	0.07
Density, D_{MD} (pc/mi/ln)	13.8	19.5	2.6
LOS	B	B	A

Formulas and Reference Material

$$f_{HV} = \frac{1}{1+P_T(E_T-1)+P_R(E_R-1)}$$ HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P}$$ HCM 2010, Equation 11-2

$$D_{MD} = \frac{0.0175*v_f}{N}$$ HCM 2010, Equation 13-26

Basic Freeway Segments Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
75	2,400
70	2,400
65	2,350
60	2,300
55	2,250

Source: HCM 2010, Exhibit 11-17

Ramp Roadways Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

Diverge LOS Thresholds

LOS	Density (pc/mi/ln)
A	≤10
B	>10-20
C	>20-28
D	>28-35
E	>35
F	v/c > 1

Source: HCM 2010, Exhibit 13-2

BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-26 WB*
Agency or Company	*Atkins*	From/To	*2025- Romney Off to US17 SB On*
Date Performed	*4/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2013*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*1338*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*2*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.990*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*55.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*55.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*751*	pc/h/ln
S	*55.0*	mph
D = v_p / S	*13.7*	pc/mi/ln
LOS	*B*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-26 WB*
Agency or Company	*Atkins*	From/To	*2025- Romney Off to US17 SB On*
Date Performed	*4/25/2014*	Jurisdiction	
Analysis Time Period	*PM Peak*	Analysis Year	*2013*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*1982*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*2*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.990*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*55.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*55.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1112*	pc/h/ln
S	*55.0*	mph
D = v_p / S	*20.2*	pc/mi/ln
LOS	*C*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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FREEWAY RAMP ADD OR DROP LANE ANALYSIS

ATKINS

General Information

Date Performed:	3/20/2014	Freeway/Direction	I-26 WB
Analysis Year	2013	Junction	WB On from US-17 SB
Analysis Time Period:	AM Peak	Segment ID	2030
Project Description:	Navy Base ICTF		

Inputs

	Freeway Upstream of Ramp	Freeway Downstream of Ramp	Ramp
Number of Lanes, N	2	3	1
Free-Flow Speed, FFS (mph)	55	55	55
Volume, V (veh/h)	1,338	2,357	1,019
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	2%	2%	2%
%RVs, P_R	0%	0%	0%

Performance Measures

	Freeway Upstream Ramp	Freeway Downstream Ramp	Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.99	0.99	0.99
Demand Flow Rate, v_p (pc/h/ln)	751	882	1,144
Capacity Flow Rate, c (pc/h/ln)	2,250	2,250	2,200
v/c ratio	0.33	0.39	0.52
Density, D_{MD} (pc/mi/ln)	13.1	15.4	20.0
LOS	B	B	B

Formulas and Reference Material

$$f_{HV} = \frac{1}{1+P_T(E_T-1)+P_R(E_R-1)}$$

HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P}$$

HCM 2010, Equation 11-2

$$D_{MD} = \frac{0.0175*v_f}{N}$$

HCM 2010, Equation 13-26

Basic Freeway Segments Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
75	2,400
70	2,400
65	2,350
60	2,300
55	2,250

Source: HCM 2010, Exhibit 11-17

Ramp Roadways Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

Diverge LOS Thresholds

LOS	Density (pc/mi/ln)
A	≤10
B	>10-20
C	>20-28
D	>28-35
E	>35
F	v/c > 1

Source: HCM 2010, Exhibit 13-2

FREEWAY RAMP ADD OR DROP LANE ANALYSIS

ATKINS

General Information

Date Performed:	3/20/2014	Freeway/Direction	I-26 WB
Analysis Year	2013	Junction	WB On from US-17 SB
Analysis Time Period:	PM Peak	Segment ID	2030
Project Description:	Navy Base ICTF		

Inputs

	Freeway Upstream of Ramp	Freeway Downstream of Ramp	Ramp
Number of Lanes, N	2	3	1
Free-Flow Speed, FFS (mph)	55	55	55
Volume, V (veh/h)	1,982	3,004	1,022
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	2%	2%	2%
%RVs, P_R	0%	0%	0%

Performance Measures

	Freeway Upstream Ramp	Freeway Downstream Ramp	Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.99	0.99	0.99
Demand Flow Rate, v_p (pc/h/ln)	1,112	1,124	1,147
Capacity Flow Rate, c (pc/h/ln)	2,250	2,250	2,200
v/c ratio	0.49	0.50	0.52
Density, D_{MD} (pc/mi/ln)	19.5	19.7	20.1
LOS	B	B	C

Formulas and Reference Material

$$f_{HV} = \frac{1}{1+P_T(E_T-1)+P_R(E_R-1)}$$ HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P}$$ HCM 2010, Equation 11-2

$$D_{MD} = \frac{0.0175*v_f}{N}$$ HCM 2010, Equation 13-26

Basic Freeway Segments Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
75	2,400
70	2,400
65	2,350
60	2,300
55	2,250

Source: HCM 2010, Exhibit 11-17

Ramp Roadways Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

Diverge LOS Thresholds

LOS	Density (pc/mi/ln)
A	≤10
B	>10-20
C	>20-28
D	>28-35
E	>35
F	v/c > 1

Source: HCM 2010, Exhibit 13-2

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-26 WB
Agency or Company	Atkins	Junction	2040 - WB On from Meeting
Date Performed	4/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2013

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Number of Lanes, N: 3	☐ Yes ☐ On
☑ No ☐ Off	Acceleration Lane Length, L_A: 600	☑ No ☐ Off
L_{up} = ft	Deceleration Lane Length L_D:	L_{down} = ft
V_u = veh/h	Freeway Volume, V_F: 2357	V_D = veh/h
	Ramp Volume, V_R: 355	
	Freeway Free-Flow Speed, S_{FF}: 55.0	
	Ramp Free-Flow Speed, S_{FR}: 45.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	2357	0.90	Level	2	0	0.990	1.00	2645
Ramp	355	0.90	Level	6	0	0.971	1.00	406
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 0.594 using Equation (Exhibit 13-6)

V_{12} = 1572 pc/h

V_3 or V_{av34} 1073 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	3051	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	1978	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = 17.0 (pc/mi/ln)

LOS = B (Exhibit 13-2)

Speed Determination

M_S = 0.295 (Exibit 13-11)

S_R= 51.2 mph (Exhibit 13-11)

S_0= 52.9 mph (Exhibit 13-11)

S = 51.8 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-26 WB
Agency or Company	Atkins	Junction	2040 - WB On from Meeting
Date Performed	4/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2013

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Number of Lanes, N: 3	☐ Yes ☐ On
☑ No ☐ Off	Acceleration Lane Length, L_A: 600	☑ No ☐ Off
L_{up} = ft	Deceleration Lane Length L_D:	L_{down} = ft
V_u = veh/h	Freeway Volume, V_F: 3004	V_D = veh/h
	Ramp Volume, V_R: 704	
	Freeway Free-Flow Speed, S_{FF}: 55.0	
	Ramp Free-Flow Speed, S_{FR}: 45.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	3004	0.90	Level	2	0	0.990	1.00	3371
Ramp	704	0.90	Level	3	0	0.985	1.00	794
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 0.594 using Equation (Exhibit 13-6)

V_{12} = 2003 pc/h

V_3 or V_{av34} 1368 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * $V_{12}/2$ ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	4165	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	2797	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = 23.2 (pc/mi/ln)

LOS = C (Exhibit 13-2)

Speed Determination

M_S = 0.331 (Exibit 13-11)

S_R= 50.7 mph (Exhibit 13-11)

S_0= 51.9 mph (Exhibit 13-11)

S = 51.1 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * $V_{12}/2$ ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-26 WB*
Agency or Company	*Atkins*	From/To	*2050 - Meeting to Mt Pleasant*
Date Performed	*4/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2013*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*2712*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*2*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.990*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*3*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*55.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*55.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1014*	pc/h/ln
S	*55.0*	mph
D = v_p / S	*18.4*	pc/mi/ln
LOS	*C*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-26 WB*
Agency or Company	*Atkins*	From/To	*2050 - Meeting to Mt Pleasant*
Date Performed	*4/25/2014*	Jurisdiction	
Analysis Time Period	*PM Peak*	Analysis Year	*2013*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*3708*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*2*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.990*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*3*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*55.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*55.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1387*	pc/h/ln
S	*55.0*	mph
D = v_p / S	*25.2*	pc/mi/ln
LOS	*C*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-26 WB
Agency or Company	Atkins	Junction	2060 - WB On from Mt Pleasant
Date Performed	4/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2013

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Number of Lanes, N	3	Downstream Adj Ramp	
☐ Yes	☐ On	Acceleration Lane Length, L_A	275	☐ Yes	☐ On
☑ No	☐ Off	Deceleration Lane Length L_D		☑ No	☐ Off
L_{up} =	ft	Freeway Volume, V_F	2712	L_{down} =	ft
V_u =	veh/h	Ramp Volume, V_R	298	V_D =	veh/h
		Freeway Free-Flow Speed, S_{FF}	55.0		
		Ramp Free-Flow Speed, S_{FR}	45.0		

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	2712	0.90	Level	2	0	0.990	1.00	3043
Ramp	298	0.90	Level	11	0	0.948	1.00	349
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 0.585 using Equation (Exhibit 13-6)

V_{12} = 1781 pc/h

V_3 or V_{av34} 1262 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	3392	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	2130	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = 20.2 (pc/mi/ln)

LOS = C (Exhibit 13-2)

Speed Determination

M_S = 0.329 (Exibit 13-11)

S_R= 50.7 mph (Exhibit 13-11)

S_0= 52.3 mph (Exhibit 13-11)

S = 51.3 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-26 WB
Agency or Company	Atkins	Junction	2060 - WB On from Mt Pleasant
Date Performed	4/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2013

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Number of Lanes, N: 3	☐ Yes ☐ On
☑ No ☐ Off	Acceleration Lane Length, L_A: 275	☑ No ☐ Off
L_{up} = ft	Deceleration Lane Length L_D:	L_{down} = ft
V_u = veh/h	Freeway Volume, V_F: 3708	V_D = veh/h
	Ramp Volume, V_R: 711	
	Freeway Free-Flow Speed, S_{FF}: 55.0	
	Ramp Free-Flow Speed, S_{FR}: 45.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	3708	0.90	Level	2	0	0.990	1.00	4161
Ramp	711	0.90	Level	8	0	0.962	1.00	822
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 0.585 using Equation (Exhibit 13-6)

V_{12} = 2435 pc/h

V_3 or V_{av34} 1726 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	4983	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	3257	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = 28.8 (pc/mi/ln)

LOS = D (Exhibit 13-2)

Speed Determination

M_S = 0.398 (Exibit 13-11)

S_R= 49.8 mph (Exhibit 13-11)

S_0= 50.6 mph (Exhibit 13-11)

S = 50.1 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-26 WB
Agency or Company	Atkins	Junction	2070 - WB On from Heriot
Date Performed	4/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2013

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Number of Lanes, N: 3	☐ Yes ☐ On
☑ No ☐ Off	Acceleration Lane Length, L_A: 1165	☑ No ☐ Off
L_{up} = ft	Deceleration Lane Length L_D:	L_{down} = ft
V_u = veh/h	Freeway Volume, V_F: 3010	V_D = veh/h
	Ramp Volume, V_R: 243	
	Freeway Free-Flow Speed, S_{FF}: 55.0	
	Ramp Free-Flow Speed, S_{FR}: 45.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	3010	0.90	Level	3	0	0.985	1.00	3395
Ramp	243	0.90	Level	2	0	0.990	1.00	273
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 0.610 using Equation (Exhibit 13-6)

V_{12} = 2071 pc/h

V_3 or V_{av34} 1324 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	3668	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	2344	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = 16.3 (pc/mi/ln)

LOS = B (Exhibit 13-2)

Speed Determination

M_S = 0.257 (Exibit 13-11)

S_R= 51.7 mph (Exhibit 13-11)

S_0= 52.0 mph (Exhibit 13-11)

S = 51.8 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-26 WB
Agency or Company	Atkins	Junction	2070 - WB On from Heriot
Date Performed	4/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2013

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Number of Lanes, N: 3	☐ Yes ☐ On
☑ No ☐ Off	Acceleration Lane Length, L_A: 1165	☑ No ☐ Off
L_{up} = ft	Deceleration Lane Length L_D:	L_{down} = ft
V_u = veh/h	Freeway Volume, V_F: 4419	V_D = veh/h
	Ramp Volume, V_R: 407	
	Freeway Free-Flow Speed, S_{FF}: 55.0	
	Ramp Free-Flow Speed, S_{FR}: 45.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	4419	0.90	Level	3	0	0.985	1.00	4984
Ramp	407	0.90	Level	4	0	0.980	1.00	461
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 0.610 using Equation (Exhibit 13-6)

V_{12} = 3041 pc/h

V_3 or V_{av34} 1943 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * $V_{12}/2$ ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	5445	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	3502	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = 25.3 (pc/mi/ln)

LOS = C (Exhibit 13-2)

Speed Determination

M_S = 0.346 (Exibit 13-11)

S_R= 50.5 mph (Exhibit 13-11)

S_0= 49.8 mph (Exhibit 13-11)

S = 50.3 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * $V_{12}/2$ ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-26 WB*
Agency or Company	*Atkins*	From/To	*2080 - Heriot to Spruill*
Date Performed	*4/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2013*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*3253*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*3*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.985*

Speed Inputs			Calc Speed Adj and FFS		
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f_{LW}		mph
Number of Lanes, N	*3*		f_{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	*60.0*	mph	FFS	*60.0*	mph
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures			Design (N)	
Operational (LOS)			Design (N)	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1223*	pc/h/ln	Design LOS	
S	*60.0*	mph	v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h/ln
D = v_p / S	*20.4*	pc/mi/ln	S	mph
LOS	*C*		D = v_p / S	pc/mi/ln
			Required Number of Lanes, N	

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-26 WB*
Agency or Company	*Atkins*	From/To	*2080 - Heriot to Spruill*
Date Performed	*4/25/2014*	Jurisdiction	
Analysis Time Period	*PM Peak*	Analysis Year	*2013*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*4826*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*3*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.985*

Speed Inputs			Calc Speed Adj and FFS		
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f_{LW}		mph
Number of Lanes, N	*3*		f_{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	*60.0*	mph	FFS	*60.0*	mph
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures			Design (N)	
Operational (LOS)			Design (N)	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1814*	pc/h/ln	Design LOS	
			v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h/ln
S	*59.2*	mph	S	mph
D = v_p / S	*30.7*	pc/mi/ln	D = v_p / S	pc/mi/ln
LOS	*D*		Required Number of Lanes, N	

Glossary		Factor Location	
N - Number of lanes	S - Speed	E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
V - Hourly volume	D - Density	E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 11-18	TRD - Page 11-11
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 11-2, 11-3	
DDHV - Directional design hour volume			

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-26 WB
Agency or Company	Atkins	Junction	2090-WB Off to Spruill
Date Performed	3/20/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2013

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Number of Lanes, N	3	Downstream Adj Ramp	
☐ Yes	☐ On	Acceleration Lane Length, L_A		☐ Yes	☐ On
☑ No	☐ Off	Deceleration Lane Length L_D	1400	☑ No	☐ Off
L_{up} =	ft	Freeway Volume, V_F	3253	L_{down} =	ft
		Ramp Volume, V_R	423		
V_u =	veh/h	Freeway Free-Flow Speed, S_{FF}	60.0	V_D =	veh/h
		Ramp Free-Flow Speed, S_{FR}	45.0		

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	3253	0.90	Level	3	0	0.985	1.00	3669
Ramp	423	0.90	Level	9	0	0.957	1.00	491
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 0.646 using Equation (Exhibit 13-7)

V_{12} = 2543 pc/h

V_3 or V_{av34} 1126 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	3669	Exhibit 13-8	6900	No
$V_{FO} = V_F - V_R$	3178	Exhibit 13-8	6900	No
V_R	491	Exhibit 13-10	2100	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	2543	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = 13.5 (pc/mi/ln)

LOS = B (Exhibit 13-2)

Speed Determination

D_s = 0.342 (Exhibit 13-12)

S_R= 53.8 mph (Exhibit 13-12)

S_0= 65.3 mph (Exhibit 13-12)

S = 56.9 mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-26 WB
Agency or Company	Atkins	Junction	2090-WB Off to Spruill
Date Performed	3/20/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2013

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Number of Lanes, N	3	Downstream Adj Ramp	
☐ Yes	☐ On	Acceleration Lane Length, L_A		☐ Yes	☐ On
☑ No	☐ Off	Deceleration Lane Length L_D	1400	☑ No	☐ Off
L_{up} =	ft	Freeway Volume, V_F	4826	L_{down} =	ft
V_u =	veh/h	Ramp Volume, V_R	339	V_D =	veh/h
		Freeway Free-Flow Speed, S_{FF}	60.0		
		Ramp Free-Flow Speed, S_{FR}	45.0		

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	4826	0.90	Level	3	0	0.985	1.00	5443
Ramp	339	0.90	Level	17	0	0.922	1.00	409
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 0.605 using Equation (Exhibit 13-7)

V_{12} = 3455 pc/h

V_3 or V_{av34} 1988 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	5443	Exhibit 13-8	6900	No
$V_{FO} = V_F - V_R$	5034	Exhibit 13-8	6900	No
V_R	409	Exhibit 13-10	2100	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	3455	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = 21.4 (pc/mi/ln)

LOS = C (Exhibit 13-2)

Speed Determination

D_s = 0.335 (Exhibit 13-12)

S_R= 54.0 mph (Exhibit 13-12)

S_0= 62.0 mph (Exhibit 13-12)

S = 56.6 mph (Exhibit 13-13)

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-26 WB*
Agency or Company	*Atkins*	From/To	*2100 - Spruill to US-52*
Date Performed	*4/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2013*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*2830*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*2*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.990*

Speed Inputs			Calc Speed Adj and FFS		
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f_{LW}		mph
Number of Lanes, N	*3*		f_{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	*60.0*	mph	FFS	*60.0*	mph
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures			Design (N)	
Operational (LOS)			Design (N)	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1059*	pc/h/ln	Design LOS	
S	*60.0*	mph	v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h/ln
D = v_p / S	*17.6*	pc/mi/ln	S	mph
LOS	*B*		D = v_p / S	pc/mi/ln
			Required Number of Lanes, N	

Glossary		Factor Location	
N - Number of lanes	S - Speed	E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
V - Hourly volume	D - Density	E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 11-18	TRD - Page 11-11
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 11-2, 11-3	
DDHV - Directional design hour volume			

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-26 WB*
Agency or Company	*Atkins*	From/To	*2100 - Spruill to US-52*
Date Performed	*4/25/2014*	Jurisdiction	
Analysis Time Period	*PM Peak*	Analysis Year	*2013*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*4487*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*2*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.990*

Speed Inputs			Calc Speed Adj and FFS		
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f_{LW}		mph
Number of Lanes, N	*3*		f_{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	*60.0*	mph	FFS	*60.0*	mph
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures			Design (N)	
Operational (LOS)			Design (N)	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1678*	pc/h/ln	Design LOS	
			v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h/ln
S	*59.9*	mph	S	mph
D = v_p / S	*28.0*	pc/mi/ln	D = v_p / S	pc/mi/ln
LOS	*D*		Required Number of Lanes, N	

Glossary		Factor Location	
N - Number of lanes	S - Speed	E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
V - Hourly volume	D - Density	E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 11-18	TRD - Page 11-11
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 11-2, 11-3	
DDHV - Directional design hour volume			

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-26 WB
Agency or Company	Atkins	Junction	2110 - WB On from US-52
Date Performed	4/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2013

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Number of Lanes, N: 3	☐ Yes ☐ On
☑ No ☐ Off	Acceleration Lane Length, L_A: 775	☑ No ☐ Off
L_{up} = ft	Deceleration Lane Length L_D:	L_{down} = ft
V_u = veh/h	Freeway Volume, V_F: 2830	V_D = veh/h
	Ramp Volume, V_R: 418	
	Freeway Free-Flow Speed, S_{FF}: 60.0	
	Ramp Free-Flow Speed, S_{FR}: 45.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	2830	0.90	Level	2	0	0.990	1.00	3176
Ramp	418	0.90	Level	8	0	0.962	1.00	483
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 0.599 using Equation (Exhibit 13-6)

V_{12} = 1903 pc/h

V_3 or V_{av34} 1273 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	3659	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	2386	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = 19.0 (pc/mi/ln)

LOS = B (Exhibit 13-2)

Speed Determination

M_S = 0.294 (Exibit 13-11)

S_R= 54.7 mph (Exhibit 13-11)

S_0= 57.2 mph (Exhibit 13-11)

S = 55.6 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-26 WB
Agency or Company	Atkins	Junction	2110 - WB On from US-52
Date Performed	4/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2013

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Number of Lanes, N: 3	☐ Yes ☐ On
☑ No ☐ Off	Acceleration Lane Length, L_A: 775	☑ No ☐ Off
L_{up} = ft	Deceleration Lane Length L_D:	L_{down} = ft
V_u = veh/h	Freeway Volume, V_F: 4487	V_D = veh/h
	Ramp Volume, V_R: 149	
	Freeway Free-Flow Speed, S_{FF}: 60.0	
	Ramp Free-Flow Speed, S_{FR}: 45.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	4487	0.90	Level	2	0	0.990	1.00	5035
Ramp	149	0.90	Level	13	0	0.939	1.00	176
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 0.599 using Equation (Exhibit 13-6)

V_{12} = 3017 pc/h

V_3 or V_{av34} 2018 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * $V_{12}/2$ ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	5211	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	3193	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = 25.4 (pc/mi/ln)

LOS = C (Exhibit 13-2)

Speed Determination

M_S = 0.346 (Exibit 13-11)

S_R= 53.8 mph (Exhibit 13-11)

S_0= 54.5 mph (Exhibit 13-11)

S = 54.1 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * $V_{12}/2$ ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-26 WB*
Agency or Company	*Atkins*	From/To	*2120 - US-52 to Cosgrove*
Date Performed	*4/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2013*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*3248*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*3*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.985*

Speed Inputs			Calc Speed Adj and FFS		
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f_{LW}		mph
Number of Lanes, N	*3*		f_{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	*60.0*	mph	FFS	*60.0*	mph
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures			Design (N)	
Operational (LOS)			Design (N)	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1221*	pc/h/ln	Design LOS	
			v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h/ln
S	*60.0*	mph	S	mph
D = v_p / S	*20.4*	pc/mi/ln	D = v_p / S	pc/mi/ln
LOS	*C*		Required Number of Lanes, N	

Glossary		Factor Location	
N - Number of lanes	S - Speed	E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
V - Hourly volume	D - Density	E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 11-18	TRD - Page 11-11
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 11-2, 11-3	
DDHV - Directional design hour volume			

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-26 WB*
Agency or Company	*Atkins*	From/To	*2120 - US-52 to Cosgrove*
Date Performed	*4/25/2014*	Jurisdiction	
Analysis Time Period	*PM Peak*	Analysis Year	*2013*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*4636*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*2*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.990*

Speed Inputs			Calc Speed Adj and FFS		
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f_{LW}		mph
Number of Lanes, N	*3*		f_{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	*60.0*	mph	FFS	*60.0*	mph
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures			Design (N)	
Operational (LOS)			Design (N)	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1734*	pc/h/ln	Design LOS	
			v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h/ln
S	*59.7*	mph	S	mph
D = v_p / S	*29.1*	pc/mi/ln	D = v_p / S	pc/mi/ln
LOS	*D*		Required Number of Lanes, N	

Glossary		Factor Location	
N - Number of lanes	S - Speed	E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
V - Hourly volume	D - Density	E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 11-18	TRD - Page 11-11
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 11-2, 11-3	
DDHV - Directional design hour volume			

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-26 WB
Agency or Company	Atkins	Junction	2130-WB Off to Cosgrove NB
Date Performed	3/20/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2013

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Number of Lanes, N	3	Downstream Adj Ramp	
☐ Yes	☐ On	Acceleration Lane Length, L_A		☐ Yes	☐ On
☑ No	☐ Off	Deceleration Lane Length L_D	525	☑ No	☐ Off
L_{up} =	ft	Freeway Volume, V_F	3248	L_{down} =	ft
V_u =	veh/h	Ramp Volume, V_R	342	V_D =	veh/h
		Freeway Free-Flow Speed, S_{FF}	60.0		
		Ramp Free-Flow Speed, S_{FR}	45.0		

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	3248	0.90	Level	3	0	0.985	1.00	3663
Ramp	342	0.90	Level	10	0	0.952	1.00	399
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 0.650 using Equation (Exhibit 13-7)

V_{12} = 2521 pc/h

V_3 or V_{av34} 1142 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	3663	Exhibit 13-8	6900	No
$V_{FO} = V_F - V_R$	3264	Exhibit 13-8	6900	No
V_R	399	Exhibit 13-10	2100	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	2521	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = 21.2 (pc/mi/ln)

LOS = C (Exhibit 13-2)

Speed Determination

D_s = 0.334 (Exhibit 13-12)

S_R= 54.0 mph (Exhibit 13-12)

S_0= 65.3 mph (Exhibit 13-12)

S = 57.1 mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-26 WB
Agency or Company	Atkins	Junction	2130-WB Off to Cosgrove NB
Date Performed	3/20/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2013

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Number of Lanes, N	3	Downstream Adj Ramp	
☐ Yes	☐ On	Acceleration Lane Length, L_A		☐ Yes	☐ On
☑ No	☐ Off	Deceleration Lane Length L_D	525	☑ No	☐ Off
L_{up} =	ft	Freeway Volume, V_F	4636	L_{down} =	ft
V_u =	veh/h	Ramp Volume, V_R	312	V_D =	veh/h
		Freeway Free-Flow Speed, S_{FF}	60.0		
		Ramp Free-Flow Speed, S_{FR}	45.0		

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	4636	0.90	Level	2	0	0.990	1.00	5203
Ramp	312	0.90	Level	13	0	0.939	1.00	369
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 0.613 using Equation (Exhibit 13-7)

V_{12} = 3332 pc/h

V_3 or V_{av34} 1871 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	5203	Exhibit 13-8	6900	No
$V_{FO} = V_F - V_R$	4834	Exhibit 13-8	6900	No
V_R	369	Exhibit 13-10	2100	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	3332	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = 28.2 (pc/mi/ln)

LOS = D (Exhibit 13-2)

Speed Determination

D_s = 0.331 (Exhibit 13-12)

S_R= 54.0 mph (Exhibit 13-12)

S_0= 62.4 mph (Exhibit 13-12)

S = 56.8 mph (Exhibit 13-13)

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-26 WB*
Agency or Company	*Atkins*	From/To	*2135-Cosg NB Off to Cosg NB On*
Date Performed	*4/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2013*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*2906*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*2*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.990*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*3*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*60.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*60.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1087*	pc/h/ln
S	*60.0*	mph
D = v_p / S	*18.1*	pc/mi/ln
LOS	*C*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-26 WB*
Agency or Company	*Atkins*	From/To	*2135-Cosg NB Off to Cosg NB On*
Date Performed	*4/25/2014*	Jurisdiction	
Analysis Time Period	*PM Peak*	Analysis Year	*2013*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*4324*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*2*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.990*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*3*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*60.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*60.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1617*	pc/h/ln
S	*60.0*	mph
D = v_p / S	*27.0*	pc/mi/ln
LOS	*D*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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Navy Base ICTF

FREEWAY WEAVING WORKSHEET

General Information

Analyst	AJR
Agency/Company	Atkins
Date Performed	3/20/2014
Analysis Time Period	AM Peak

Site Information

Freeway/Dir of Travel	I-26 WB
Weaving Segment Location	2140 - Cosgrove NB to Cos. SB
Analysis Year	2013

Project Description *Navy Base ICTF*

Inputs

Weaving configuration	One-Sided
Weaving number of lanes, N	4
Weaving segment length, L_S	560ft
Freeway free-flow speed, FFS	60 mph
Segment type	Freeway
Freeway minimum speed, S_{MIN}	15
Freeway maximum capacity, C_{IFL}	2300
Terrain type	Level

Conversions to pc/h Under Base Conditions

	V (veh/h)	PHF	Truck (%)	RV (%)	E_T	E_R	f_{HV}	f_p	v (pc/h)
V_{FF}	2558	0.90	2	0	1.5	1.2	0.990	1.00	2871
V_{RF}	817	0.90	16	0	1.5	1.2	0.926	1.00	980
V_{FR}	348	0.90	21	0	1.5	1.2	0.905	1.00	427
V_{RR}	0	0.90	0	0	1.5	1.2	1.000	1.00	0
V_{NW}	2871							V =	4278
V_W	1407								
VR	0.329								

Configuration Characteristics

Minimum maneuver lanes, N_{WL}	2 lc	Minimum weaving lane changes, LC_{MIN}	1407 lc/h
Interchange density, ID	1.0 int/mi	Weaving lane changes, LC_W	1582 lc/h
Minimum RF lane changes, LC_{RF}	1 lc/pc	Non-weaving lane changes, LC_{NW}	125 lc/h
Minimum FR lane changes, LC_{FR}	1 lc/pc	Total lane changes, LC_{ALL}	1707 lc/h
Minimum RR lane changes, LC_{RR}	lc/pc	Non-weaving vehicle index, I_{NW}	161

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment flow rate, v	4278 pc/h	Weaving intensity factor, W	0.545
Weaving segment capacity, c_w	7225 veh/h	Weaving segment speed, S	44.5 mph
Weaving segment v/c ratio	0.586	Average weaving speed, S_W	44.1 mph
Weaving segment density, D	24.0 pc/mi/ln	Average non-weaving speed, S_{NW}	44.7 mph
Level of Service, LOS	C	Maximum weaving length, L_{MAX}	5896 ft

Notes

a. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments".
b. For volumes that exceed the weaving segment capacity, the level of service is "F".

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Navy Base ICTF

FREEWAY WEAVING WORKSHEET

General Information

Analyst	AJR
Agency/Company	Atkins
Date Performed	3/20/2014
Analysis Time Period	PM Peak

Site Information

Freeway/Dir of Travel	I-26 WB
Weaving Segment Location	2140 - Cosgrove NB to Cos. SB
Analysis Year	2013

Project Description *Navy Base ICTF*

Inputs

Weaving configuration	One-Sided	Segment type	Freeway
Weaving number of lanes, N	4	Freeway minimum speed, S_{MIN}	15
Weaving segment length, L_S	560ft	Freeway maximum capacity, C_{IFL}	2300
Freeway free-flow speed, FFS	60 mph	Terrain type	Level

Conversions to pc/h Under Base Conditions

	V (veh/h)	PHF	Truck (%)	RV (%)	E_T	E_R	f_{HV}	f_p	v (pc/h)
V_{FF}	3515	0.90	2	0	1.5	1.2	0.990	1.00	3945
V_{RF}	745	0.90	12	0	1.5	1.2	0.943	1.00	877
V_{FR}	809	0.90	19	0	1.5	1.2	0.913	1.00	984
V_{RR}	0	0.90	0	0	1.5	1.2	1.000	1.00	0
V_{NW}	3945							V =	5806
V_W	1861								
VR	0.321								

Configuration Characteristics

Minimum maneuver lanes, N_{WL}	2 lc	Minimum weaving lane changes, LC_{MIN}	lc/h
Interchange density, ID	1.0 int/mi	Weaving lane changes, LC_W	lc/h
Minimum RF lane changes, LC_{RF}	1 lc/pc	Non-weaving lane changes, LC_{NW}	346 lc/h
Minimum FR lane changes, LC_{FR}	1 lc/pc	Total lane changes, LC_{ALL}	lc/h
Minimum RR lane changes, LC_{RR}	lc/pc	Non-weaving vehicle index, I_{NW}	221

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment flow rate, v	5806 pc/h	Weaving intensity factor, W	
Weaving segment capacity, c_w	7413 veh/h	Weaving segment speed, S	mph
Weaving segment v/c ratio	0.775	Average weaving speed, S_W	mph
Weaving segment density, D	pc/mi/ln	Average non-weaving speed, S_{NW}	mph
Level of Service, LOS		Maximum weaving length, L_{MAX}	5805 ft

Notes

a. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments".
b. For volumes that exceed the weaving segment capacity, the level of service is "F".

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-26 WB*
Agency or Company	*Atkins*	From/To	*2145-Cosg SB Off to Cosg SB On*
Date Performed	*4/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2013*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*3375*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*3*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.985*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*3*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*60.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*60.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1269*	pc/h/ln
S	*60.0*	mph
D = v_p / S	*21.1*	pc/mi/ln
LOS	*C*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-26 WB*
Agency or Company	*Atkins*	From/To	*2145-Cosg SB Off to Cosg SB On*
Date Performed	*4/25/2014*	Jurisdiction	
Analysis Time Period	*PM Peak*	Analysis Year	*2013*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*4260*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*3*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.985*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*3*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*60.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*60.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1601*	pc/h/ln
S	*60.0*	mph
D = v_p / S	*26.7*	pc/mi/ln
LOS	*D*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-26 WB
Agency or Company	Atkins	Junction	2150 - WB On from Cosgrove SB
Date Performed	4/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2013

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Number of Lanes, N: 3	☑ Yes ☐ On
☑ No ☐ Off	Acceleration Lane Length, L_A: 425	☐ No ☑ Off
L_{up} = ft	Deceleration Lane Length L_D:	L_{down} = 2390 ft
V_u = veh/h	Freeway Volume, V_F: 3375	V_D = 339 veh/h
	Ramp Volume, V_R: 140	
	Freeway Free-Flow Speed, S_{FF}: 60.0	
	Ramp Free-Flow Speed, S_{FR}: 45.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	3375	0.90	Level	3	0	0.985	1.00	3806
Ramp	140	0.90	Level	21	0	0.905	1.00	172
UpStream								
DownStream	339	0.90	Level	20	0	0.909	1.00	414

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = 2669.68 (Equation 13-6 or 13-7)

P_{FM} = 0.594 using Equation (Exhibit 13-6)

V_{12} = 2262 pc/h

V_3 or V_{av34} 1544 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * $V_{12}/2$ ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	3978	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	2434	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = 21.7 (pc/mi/ln)

LOS = C (Exhibit 13-2)

Speed Determination

M_S = 0.327 (Exibit 13-11)

S_R= 54.1 mph (Exhibit 13-11)

S_0= 56.2 mph (Exhibit 13-11)

S = 54.9 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * $V_{12}/2$ ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-26 WB
Agency or Company	Atkins	Junction	2150 - WB On from Cosgrove SB
Date Performed	4/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2013

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Number of Lanes, N: 3	☑ Yes ☐ On
☑ No ☐ Off	Acceleration Lane Length, L_A: 425	☐ No ☑ Off
L_{up} = ft	Deceleration Lane Length L_D:	L_{down} = 2390 ft
V_u = veh/h	Freeway Volume, V_F: 4260	V_D = 390 veh/h
	Ramp Volume, V_R: 294	
	Freeway Free-Flow Speed, S_{FF}: 60.0	
	Ramp Free-Flow Speed, S_{FR}: 45.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	4260	0.90	Level	3	0	0.985	1.00	4804
Ramp	294	0.90	Level	10	0	0.952	1.00	343
UpStream								
DownStream	390	0.90	Level	18	0	0.917	1.00	472

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = 3043.69 (Equation 13-6 or 13-7)

P_{FM} = 0.601 using Equation (Exhibit 13-6)

V_{12} = 2885 pc/h

V_3 or V_{av34} 1919 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * $V_{12}/2$ ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	5147	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	3228	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = 27.8 (pc/mi/ln)

LOS = C (Exhibit 13-2)

Speed Determination

M_S = 0.381 (Exibit 13-11)

S_R= 53.1 mph (Exhibit 13-11)

S_0= 54.9 mph (Exhibit 13-11)

S = 53.8 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * $V_{12}/2$ ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-26 WB
Agency or Company	Atkins	Junction	2160-WB Off to Dorchester
Date Performed	3/20/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2013

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☑ Yes ☑ On	Number of Lanes, N: 3	☐ Yes ☐ On
☐ No ☐ Off	Acceleration Lane Length, L_A:	☑ No ☐ Off
L_{up} = 2390 ft	Deceleration Lane Length L_D: 425	L_{down} = ft
V_u = 140 veh/h	Freeway Volume, V_F: 3515	V_D = veh/h
	Ramp Volume, V_R: 339	
	Freeway Free-Flow Speed, S_{FF}: 60.0	
	Ramp Free-Flow Speed, S_{FR}: 45.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	3515	0.90	Level	4	0	0.980	1.00	3984
Ramp	339	0.90	Level	20	0	0.909	1.00	414
UpStream	140	0.90	Level	21	0	0.905	1.00	172
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = 1311.30 (Equation 13-12 or 13-13)

P_{FD} = 0.641 using Equation (Exhibit 13-7)

V_{12} = 2704 pc/h

V_3 or V_{av34} 1280 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	3984	Exhibit 13-8	6900	No
$V_{FO} = V_F - V_R$	3570	Exhibit 13-8	6900	No
V_R	414	Exhibit 13-10	2100	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	2704	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = 23.7 (pc/mi/ln)

LOS = C (Exhibit 13-2)

Speed Determination

D_s = 0.335 (Exhibit 13-12)

S_R= 54.0 mph (Exhibit 13-12)

S_0= 64.7 mph (Exhibit 13-12)

S = 57.0 mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-26 WB
Agency or Company	Atkins	Junction	2160-WB Off to Dorchester
Date Performed	3/20/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2013

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Number of Lanes, N	3	Downstream Adj Ramp	
☑ Yes	☑ On	Acceleration Lane Length, L_A		☐ Yes	☐ On
☐ No	☐ Off	Deceleration Lane Length L_D	425	☑ No	☐ Off
L_{up} =	2390 ft	Freeway Volume, V_F	4554	L_{down} =	ft
V_u =	294 veh/h	Ramp Volume, V_R	390	V_D =	veh/h
		Freeway Free-Flow Speed, S_{FF}	60.0		
		Ramp Free-Flow Speed, S_{FR}	45.0		

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	4554	0.90	Level	3	0	0.985	1.00	5136
Ramp	390	0.90	Level	18	0	0.917	1.00	472
UpStream	294	0.90	Level	10	0	0.952	1.00	343
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = 2238.09 (Equation 13-12 or 13-13)

P_{FD} = 0.610 using Equation (Exhibit 13-7)

V_{12} = 3317 pc/h

V_3 or V_{av34} 1819 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	5136	Exhibit 13-8	6900	No
$V_{FO} = V_F - V_R$	4664	Exhibit 13-8	6900	No
V_R	472	Exhibit 13-10	2100	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	3317	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = 29.0 (pc/mi/ln)

LOS = D (Exhibit 13-2)

Speed Determination

D_s = 0.340 (Exhibit 13-12)

S_R= 53.9 mph (Exhibit 13-12)

S_0= 62.6 mph (Exhibit 13-12)

S = 56.7 mph (Exhibit 13-13)

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-26 WB*
Agency or Company	*Atkins*	From/To	*2165-Dorches Off to Dorches On*
Date Performed	*4/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2013*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*3176*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*2*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.990*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*3*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*60.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*60.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1188*	pc/h/ln
S	*60.0*	mph
D = v_p / S	*19.8*	pc/mi/ln
LOS	*C*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-26 WB*
Agency or Company	*Atkins*	From/To	*2165-Dorches Off to Dorches On*
Date Performed	*4/25/2014*	Jurisdiction	
Analysis Time Period	*PM Peak*	Analysis Year	*2013*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*4164*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*2*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.990*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*3*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*60.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*60.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1558*	pc/h/ln
S	*60.0*	mph
D = v_p / S	*26.0*	pc/mi/ln
LOS	*C*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-26 WB
Agency or Company	Atkins	Junction	2170 - WB On from Dorchester
Date Performed	4/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2013

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Number of Lanes, N: 3	☐ Yes ☐ On
☑ No ☐ Off	Acceleration Lane Length, L_A: 600	☑ No ☐ Off
L_{up} = ft	Deceleration Lane Length L_D:	L_{down} = ft
V_u = veh/h	Freeway Volume, V_F: 3176	V_D = veh/h
	Ramp Volume, V_R: 212	
	Freeway Free-Flow Speed, S_{FF}: 60.0	
	Ramp Free-Flow Speed, S_{FR}: 45.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	3176	0.90	Level	2	0	0.990	1.00	3564
Ramp	212	0.90	Level	15	0	0.930	1.00	253
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 0.594 using Equation (Exhibit 13-6)

V_{12} = 2118 pc/h

V_3 or V_{av34} 1446 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * $V_{12}/2$ ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	3817	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	2371	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = 20.1 (pc/mi/ln)

LOS = C (Exhibit 13-2)

Speed Determination

M_S = 0.309 (Exibit 13-11)

S_R= 54.4 mph (Exhibit 13-11)

S_0= 56.6 mph (Exhibit 13-11)

S = 55.2 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * $V_{12}/2$ ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-26 WB
Agency or Company	Atkins	Junction	2170 - WB On from Dorchester
Date Performed	4/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2013

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Number of Lanes, N: 3	☐ Yes ☐ On
☑ No ☐ Off	Acceleration Lane Length, L_A: 600	☑ No ☐ Off
L_{up} = ft	Deceleration Lane Length L_D:	L_{down} = ft
V_u = veh/h	Freeway Volume, V_F: 4164	V_D = veh/h
	Ramp Volume, V_R: 505	
	Freeway Free-Flow Speed, S_{FF}: 60.0	
	Ramp Free-Flow Speed, S_{FR}: 45.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	4164	0.90	Level	2	0	0.990	1.00	4673
Ramp	505	0.90	Level	13	0	0.939	1.00	598
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 0.594 using Equation (Exhibit 13-6)

V_{12} = 2777 pc/h

V_3 or V_{av34} 1896 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	5271	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	3375	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = 27.8 (pc/mi/ln)

LOS = C (Exhibit 13-2)

Speed Determination

M_S = 0.381 (Exibit 13-11)

S_R= 53.1 mph (Exhibit 13-11)

S_0= 55.0 mph (Exhibit 13-11)

S = 53.8 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-26 WB*
Agency or Company	*Atkins*	From/To	*2180 - Dorchester to Montague*
Date Performed	*4/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2013*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*3388*	veh/h	Peak-Hour Factor, PHF	*0.90*	
AADT		veh/day	%Trucks and Buses, P_T	*3*	
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*	
Peak-Hr Direction Prop, D			General Terrain:	*Level*	
DDHV = AADT x K x D		veh/h	Grade % Length	*mi*	
			Up/Down %		

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.985*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*3*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*60.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*60.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1274*	pc/h/ln
S	*60.0*	mph
D = v_p / S	*21.2*	pc/mi/ln
LOS	*C*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-26 WB*
Agency or Company	*Atkins*	From/To	*2180 - Dorchester to Montague*
Date Performed	*4/25/2014*	Jurisdiction	
Analysis Time Period	*PM Peak*	Analysis Year	*2013*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*4669*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*3*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.985*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*3*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*60.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*60.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1755*	pc/h/ln
S	*59.6*	mph
D = v_p / S	*29.5*	pc/mi/ln
LOS	*D*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-26 WB
Agency or Company	Atkins	Junction	2190-WB Off to Montague
Date Performed	3/20/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2013

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Number of Lanes, N: 3	☐ Yes ☐ On
☑ No ☐ Off	Acceleration Lane Length, L_A:	☑ No ☐ Off
L_{up} = ft	Deceleration Lane Length L_D: 240	L_{down} = ft
V_u = veh/h	Freeway Volume, V_F: 3388	V_D = veh/h
	Ramp Volume, V_R: 798	
	Freeway Free-Flow Speed, S_{FF}: 60.0	
	Ramp Free-Flow Speed, S_{FR}: 45.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	3388	0.90	Level	3	0	0.985	1.00	3821
Ramp	798	0.90	Level	7	0	0.966	1.00	918
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 0.622 using Equation (Exhibit 13-7)

V_{12} = 2724 pc/h

V_3 or V_{av34} 1097 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	3821	Exhibit 13-8	6900	No
$V_{FO} = V_F - V_R$	2903	Exhibit 13-8	6900	No
V_R	918	Exhibit 13-10	2100	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	2724	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = 25.5 (pc/mi/ln)

LOS = C (Exhibit 13-2)

Speed Determination

D_s = 0.381 (Exhibit 13-12)

S_R= 53.1 mph (Exhibit 13-12)

S_0= 65.4 mph (Exhibit 13-12)

S = 56.2 mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-26 WB
Agency or Company	Atkins	Junction	2190-WB Off to Montague
Date Performed	3/20/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2013

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Number of Lanes, N	3	Downstream Adj Ramp	
☐ Yes	☐ On	Acceleration Lane Length, L_A		☐ Yes	☐ On
☑ No	☐ Off	Deceleration Lane Length L_D	240	☑ No	☐ Off
L_{up} =	ft	Freeway Volume, V_F	4669	L_{down} =	ft
		Ramp Volume, V_R	808		
V_u =	veh/h	Freeway Free-Flow Speed, S_{FF}	60.0	V_D =	veh/h
		Ramp Free-Flow Speed, S_{FR}	45.0		

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	4669	0.90	Level	3	0	0.985	1.00	5266
Ramp	808	0.90	Level	7	0	0.966	1.00	929
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 0.586 using Equation (Exhibit 13-7)

V_{12} = 3469 pc/h

V_3 or V_{av34} 1797 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	5266	Exhibit 13-8	6900	No
$V_{FO} = V_F - V_R$	4337	Exhibit 13-8	6900	No
V_R	929	Exhibit 13-10	2100	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	3469	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = 31.9 (pc/mi/ln)

LOS = D (Exhibit 13-2)

Speed Determination

D_s = 0.382 (Exhibit 13-12)

S_R= 53.1 mph (Exhibit 13-12)

S_0= 62.7 mph (Exhibit 13-12)

S = 56.1 mph (Exhibit 13-13)

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-26 WB*
Agency or Company	*Atkins*	From/To	*2195-Montagu Off to Montagu On*
Date Performed	*4/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2013*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*2590*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*2*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.990*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*3*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*60.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*60.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*969*	pc/h/ln
S	*60.0*	mph
D = v_p / S	*16.1*	pc/mi/ln
LOS	*B*	

Design (N)

Design (N)

Design LOS	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h/ln
S	mph
D = v_p / S	pc/mi/ln
Required Number of Lanes, N	

Glossary

N - Number of lanes
S - Speed
V - Hourly volume
D - Density
v_p - Flow rate
FFS - Free-flow speed
LOS - Level of service
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
f_{LW} - Exhibit 11-8
E_T - Exhibits 11-10, 11-11, 11-13
f_{LC} - Exhibit 11-9
f_p - Page 11-18
TRD - Page 11-11
LOS, S, FFS, v_p - Exhibits 11-2, 11-3

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-26 WB*
Agency or Company	*Atkins*	From/To	*2195-Montagu Off to Montagu On*
Date Performed	*4/25/2014*	Jurisdiction	
Analysis Time Period	*PM Peak*	Analysis Year	*2013*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*3861*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*2*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.990*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*3*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*60.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*60.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1444*	pc/h/ln
S	*60.0*	mph
D = v_p / S	*24.1*	pc/mi/ln
LOS	*C*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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Navy Base ICTF

FREEWAY WEAVING WORKSHEET

General Information

Analyst	AJR
Agency/Company	Atkins
Date Performed	3/20/2014
Analysis Time Period	AM Peak

Site Information

Freeway/Dir of Travel	I-26 WB
Weaving Segment Location	2200 - Montague to I-526 EB
Analysis Year	2013

Project Description *Navy Base ICTF*

Inputs

Weaving configuration	One-Sided	Segment type	Freeway
Weaving number of lanes, N	4	Freeway minimum speed, S_{MIN}	15
Weaving segment length, L_S	1920ft	Freeway maximum capacity, C_{IFL}	2300
Freeway free-flow speed, FFS	60 mph	Terrain type	Level

Conversions to pc/h Under Base Conditions

	V (veh/h)	PHF	Truck (%)	RV (%)	E_T	E_R	f_{HV}	f_p	v (pc/h)
V_{FF}	2162	0.90	2	0	1.5	1.2	0.990	1.00	2426
V_{RF}	316	0.90	15	0	1.5	1.2	0.930	1.00	377
V_{FR}	428	0.90	6	0	1.5	1.2	0.971	1.00	490
V_{RR}	62	0.90	63	0	1.5	1.2	0.760	1.00	91
V_{NW}	2517							V =	3384
V_W	867								
VR	0.256								

Configuration Characteristics

Minimum maneuver lanes, N_{WL}	2 lc	Minimum weaving lane changes, LC_{MIN}	867 lc/h
Interchange density, ID	0.8 int/mi	Weaving lane changes, LC_W	1269 lc/h
Minimum RF lane changes, LC_{RF}	1 lc/pc	Non-weaving lane changes, LC_{NW}	789 lc/h
Minimum FR lane changes, LC_{FR}	1 lc/pc	Total lane changes, LC_{ALL}	2058 lc/h
Minimum RR lane changes, LC_{RR}	lc/pc	Non-weaving vehicle index, I_{NW}	387

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment flow rate, v	3384 pc/h	Weaving intensity factor, W	0.239
Weaving segment capacity, c_w	8139 veh/h	Weaving segment speed, S	50.1 mph
Weaving segment v/c ratio	0.412	Average weaving speed, S_W	51.3 mph
Weaving segment density, D	16.9 pc/mi/ln	Average non-weaving speed, S_{NW}	49.7 mph
Level of Service, LOS	B	Maximum weaving length, L_{MAX}	5119 ft

Notes

a. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments".
b. For volumes that exceed the weaving segment capacity, the level of service is "F".

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Navy Base ICTF

FREEWAY WEAVING WORKSHEET

General Information

Analyst	AJR
Agency/Company	Atkins
Date Performed	3/20/2014
Analysis Time Period	PM Peak

Site Information

Freeway/Dir of Travel	I-26 WB
Weaving Segment Location	2200 - Montague to I-526 EB
Analysis Year	2013

Project Description *Navy Base ICTF*

Inputs

Weaving configuration	One-Sided	Segment type	Freeway
Weaving number of lanes, N	4	Freeway minimum speed, S_{MIN}	15
Weaving segment length, L_S	1920ft	Freeway maximum capacity, C_{IFL}	2300
Freeway free-flow speed, FFS	60 mph	Terrain type	Level

Conversions to pc/h Under Base Conditions

	V (veh/h)	PHF	Truck (%)	RV (%)	E_T	E_R	f_{HV}	f_p	v (pc/h)
V_{FF}	3514	0.90	2	0	1.5	1.2	0.990	1.00	3943
V_{RF}	951	0.90	4	0	1.5	1.2	0.980	1.00	1078
V_{FR}	347	0.90	9	0	1.5	1.2	0.957	1.00	403
V_{RR}	94	0.90	29	0	1.5	1.2	0.873	1.00	120
V_{NW}	4063							V =	5544
V_W	1481								
VR	0.267								

Configuration Characteristics

Minimum maneuver lanes, N_{WL}	2 lc	Minimum weaving lane changes, LC_{MIN}	1481 lc/h
Interchange density, ID	0.8 int/mi	Weaving lane changes, LC_W	1883 lc/h
Minimum RF lane changes, LC_{RF}	1 lc/pc	Non-weaving lane changes, LC_{NW}	1107 lc/h
Minimum FR lane changes, LC_{FR}	1 lc/pc	Total lane changes, LC_{ALL}	2990 lc/h
Minimum RR lane changes, LC_{RR}	lc/pc	Non-weaving vehicle index, I_{NW}	624

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment flow rate, v	5544 pc/h	Weaving intensity factor, W	0.321
Weaving segment capacity, c_w	8103 veh/h	Weaving segment speed, S	44.2 mph
Weaving segment v/c ratio	0.677	Average weaving speed, S_W	49.1 mph
Weaving segment density, D	31.3 pc/mi/ln	Average non-weaving speed, S_{NW}	42.7 mph
Level of Service, LOS	D	Maximum weaving length, L_{MAX}	5234 ft

Notes

a. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments".
b. For volumes that exceed the weaving segment capacity, the level of service is "F".

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-26 WB
Agency or Company	Atkins	Junction	2210-WB Off to I-526 WB
Date Performed	3/20/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2013

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Freeway Number of Lanes, N: 3	☐ Yes ☐ On
☑ No ☐ Off	Ramp Number of Lanes, N: 1	☑ No ☐ Off
L_{up} = ft	Acceleration Lane Length, L_A	L_{down} = ft
V_u = veh/h	Deceleration Lane Length L_D: 830	V_D = veh/h
	Freeway Volume, V_F: 2478	
	Ramp Volume, V_R: 267	
	Freeway Free-Flow Speed, S_{FF}: 60.0	
	Ramp Free-Flow Speed, S_{FR}: 25.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	2478	0.90	Level	3	0	0.985	1.00	2795
Ramp	267	0.90	Level	7	0	0.966	1.00	307
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 0.676 using Equation (Exhibit 13-7)

V_{12} = 1989 pc/h

V_3 or V_{av34} 806 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	2795	Exhibit 13-8	6900	No
$V_{FO} = V_F - V_R$	2488	Exhibit 13-8	6900	No
V_R	307	Exhibit 13-10	1900	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	1989	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = 13.9 (pc/mi/ln)

LOS = B (Exhibit 13-2)

Speed Determination

D_s = 0.586 (Exhibit 13-12)

S_R= 49.5 mph (Exhibit 13-12)

S_0= 65.8 mph (Exhibit 13-12)

S = 53.3 mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-26 WB
Agency or Company	Atkins	Junction	2210-WB Off to I-526 WB
Date Performed	3/20/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2013

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Freeway Number of Lanes, N	3	Downstream Adj Ramp	
☐ Yes	☐ On	Ramp Number of Lanes, N	1	☐ Yes	☐ On
☑ No	☐ Off	Acceleration Lane Length, L_A		☑ No	☐ Off
L_{up} =	ft	Deceleration Lane Length L_D	830	L_{down} =	ft
V_u =	veh/h	Freeway Volume, V_F	4465	V_D =	veh/h
		Ramp Volume, V_R	328		
		Freeway Free-Flow Speed, S_{FF}	60.0		
		Ramp Free-Flow Speed, S_{FR}	25.0		

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	4465	0.90	Level	2	0	0.990	1.00	5011
Ramp	328	0.90	Level	5	0	0.976	1.00	374
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 0.618 using Equation (Exhibit 13-7)

V_{12} = 3237 pc/h

V_3 or V_{av34} 1774 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	5011	Exhibit 13-8	6900	No
$V_{FO} = V_F - V_R$	4637	Exhibit 13-8	6900	No
V_R	374	Exhibit 13-10	1900	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	3237	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = 24.6 (pc/mi/ln)

LOS = C (Exhibit 13-2)

Speed Determination

D_s = 0.592 (Exhibit 13-12)

S_R= 49.4 mph (Exhibit 13-12)

S_0= 62.8 mph (Exhibit 13-12)

S = 53.4 mph (Exhibit 13-13)

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-26 WB*
Agency or Company	*Atkins*	From/To	*2215- I-526 WB Off to EB&WB On*
Date Performed	*4/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2013*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*2211*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*2*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.990*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*3*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*60.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*60.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*827*	pc/h/ln
S	*60.0*	mph
D = v_p / S	*13.8*	pc/mi/ln
LOS	*B*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-26 WB*
Agency or Company	*Atkins*	From/To	*2215- I-526 WB Off to EB&WB On*
Date Performed	*4/25/2014*	Jurisdiction	
Analysis Time Period	*PM Peak*	Analysis Year	*2013*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*4137*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*2*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.990*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*3*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*60.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*60.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1548*	pc/h/ln
S	*60.0*	mph
D = v_p / S	*25.8*	pc/mi/ln
LOS	*C*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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RAMP ADD OR DROP LANE ANALYSIS (MAINLINE <55 MPH)

ATKINS

General Information

Date Performed:	3/20/2014	Freeway/Direction	I-26 WB
Analysis Year	2013	Junction	On from 526 WB & EB
Analysis Time Period:	AM Peak	Segment ID	2218
Project Description:	Navy Base ICTF		

Inputs

	Mainline Upstream Ramp	Mainline Downstream Ramp	Ramp
Number of Lanes, N	1	2	1
Free-Flow Speed, FFS (mph)	55	55	55
Volume, V (veh/h)	1,528	2,712	1,184
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	7%	14%	22%
%RVs, P_R	0%	0%	0%

Performance Measures

	Upstream of Off-Ramp	Downstream of Off-Ramp	Off-Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.97	0.93	0.90
Demand Flow Rate, v_p (pc/h/ln)	1,757	1,612	1,460
Capacity Flow Rate, c (pc/h/ln)	2,200	2,200	2,200
v/c ratio	0.80	0.73	0.66
Density, D_{MD} (pc/mi/ln)	30.7	28.2	25.6
LOS	D	D	C

Formulas and Reference Material

$$f_{HV} = \frac{1}{1+P_T(E_T-1)+P_R(E_R-1)}$$ HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P}$$ HCM 2010, Equation 11-2

$$D_{MD} = \frac{0.0175*v_f}{N}$$ HCM 2010, Equation 13-26

Ramp Roadways Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

Diverge LOS Thresholds

LOS	Density (pc/mi/ln)
A	≤10
B	>10-20
C	>20-28
D	>28-35
E	>35
F	v/c > 1

Source: HCM 2010, Exhibit 13-2

RAMP ADD OR DROP LANE ANALYSIS (MAINLINE <55 MPH)

ATKINS

General Information

Date Performed:	3/20/2014	Freeway/Direction	I-26 WB
Analysis Year	2013	Junction	On from 526 WB & EB
Analysis Time Period:	PM Peak	Segment ID	2218
Project Description:	Navy Base ICTF		

Inputs

	Mainline Upstream Ramp	Mainline Downstream Ramp	Ramp
Number of Lanes, N	1	2	1
Free-Flow Speed, FFS (mph)	55	55	55
Volume, V (veh/h)	1,767	3,193	1,426
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	9%	17%	26%
%RVs, P_R	0%	0%	0%

Performance Measures

	Upstream of Off-Ramp	Downstream of Off-Ramp	Off-Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.96	0.92	0.88
Demand Flow Rate, v_p (pc/h/ln)	2,052	1,925	1,790
Capacity Flow Rate, c (pc/h/ln)	2,200	2,200	2,200
v/c ratio	0.93	0.88	0.81
Density, D_{MD} (pc/mi/ln)	35.9	33.7	31.3
LOS	E	D	D

Formulas and Reference Material

$$f_{HV} = \frac{1}{1+P_T(E_T-1)+P_R(E_R-1)}$$ HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P}$$ HCM 2010, Equation 11-2

$$D_{MD} = \frac{0.0175*v_f}{N}$$ HCM 2010, Equation 13-26

Ramp Roadways Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

Diverge LOS Thresholds

LOS	Density (pc/mi/ln)
A	≤10
B	>10-20
C	>20-28
D	>28-35
E	>35
F	v/c > 1

Source: HCM 2010, Exhibit 13-2

Navy Base ICTF

FREEWAY WEAVING WORKSHEET

General Information

Analyst	AJR
Agency/Company	Atkins
Date Performed	3/20/2014
Analysis Time Period	AM Peak

Site Information

Freeway/Dir of Travel	I-26 WB
Weaving Segment Location	2220 - 526 to Rem/Aviation C-D
Analysis Year	2013

Project Description *Navy Base ICTF*

Inputs

Weaving configuration	One-Sided	Segment type	Freeway
Weaving number of lanes, N	5	Freeway minimum speed, S_{MIN}	15
Weaving segment length, L_S	2285ft	Freeway maximum capacity, C_{IFL}	2300
Freeway free-flow speed, FFS	60 mph	Terrain type	Level

Conversions to pc/h Under Base Conditions

	V (veh/h)	PHF	Truck (%)	RV (%)	E_T	E_R	f_{HV}	f_p	v (pc/h)
V_{FF}	1680	0.90	3	0	1.5	1.2	0.985	1.00	1895
V_{RF}	2060	0.90	17	0	1.5	1.2	0.922	1.00	2483
V_{FR}	531	0.90	2	0	1.5	1.2	0.990	1.00	596
V_{RR}	652	0.90	3	0	1.5	1.2	0.985	1.00	735
V_{NW}	2630							V =	5709
V_W	3079								
VR	0.539								

Configuration Characteristics

Minimum maneuver lanes, N_{WL}	3 lc	Minimum weaving lane changes, LC_{MIN}	596 lc/h
Interchange density, ID	0.7 int/mi	Weaving lane changes, LC_W	1260 lc/h
Minimum RF lane changes, LC_{RF}	0 lc/pc	Non-weaving lane changes, LC_{NW}	817 lc/h
Minimum FR lane changes, LC_{FR}	1 lc/pc	Total lane changes, LC_{ALL}	2077 lc/h
Minimum RR lane changes, LC_{RR}	lc/pc	Non-weaving vehicle index, I_{NW}	421

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment flow rate, v	5709 pc/h	Weaving intensity factor, W	0.210
Weaving segment capacity, c_w	6394 veh/h	Weaving segment speed, S	51.3 mph
Weaving segment v/c ratio	0.880	Average weaving speed, S_W	52.2 mph
Weaving segment density, D	22.3 pc/mi/ln	Average non-weaving speed, S_{NW}	50.2 mph
Level of Service, LOS	C	Maximum weaving length, L_{MAX}	6724 ft

Notes

a. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments".
b. For volumes that exceed the weaving segment capacity, the level of service is "F".

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Navy Base ICTF

FREEWAY WEAVING WORKSHEET

General Information

Analyst	AJR
Agency/Company	Atkins
Date Performed	3/20/2014
Analysis Time Period	PM Peak

Site Information

Freeway/Dir of Travel	I-26 WB
Weaving Segment Location	2220 - 526 to Rem/Aviation C-D
Analysis Year	2013

Project Description *Navy Base ICTF*

Inputs

Weaving configuration	One-Sided	Segment type	Freeway
Weaving number of lanes, N	5	Freeway minimum speed, S_{MIN}	15
Weaving segment length, L_S	2285ft	Freeway maximum capacity, C_{IFL}	2300
Freeway free-flow speed, FFS	60 mph	Terrain type	Level

Conversions to pc/h Under Base Conditions

	V (veh/h)	PHF	Truck (%)	RV (%)	E_T	E_R	f_{HV}	f_p	v (pc/h)
V_{FF}	3631	0.90	2	0	1.5	1.2	0.990	1.00	4075
V_{RF}	2803	0.90	18	0	1.5	1.2	0.917	1.00	3395
V_{FR}	506	0.90	2	0	1.5	1.2	0.990	1.00	568
V_{RR}	390	0.90	11	0	1.5	1.2	0.948	1.00	457
V_{NW}	4532							V =	8495
V_W	3963								
VR	0.467								

Configuration Characteristics

Minimum maneuver lanes, N_{WL}	3 lc	Minimum weaving lane changes, LC_{MIN}	lc/h
Interchange density, ID	0.7 int/mi	Weaving lane changes, LC_W	lc/h
Minimum RF lane changes, LC_{RF}	0 lc/pc	Non-weaving lane changes, LC_{NW}	lc/h
Minimum FR lane changes, LC_{FR}	1 lc/pc	Total lane changes, LC_{ALL}	lc/h
Minimum RR lane changes, LC_{RR}	lc/pc	Non-weaving vehicle index, I_{NW}	

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment flow rate, v	8495 pc/h	Weaving intensity factor, W	
Weaving segment capacity, c_w	7428 veh/h	Weaving segment speed, S	mph
Weaving segment v/c ratio	1.132	Average weaving speed, S_W	mph
Weaving segment density, D	pc/mi/ln	Average non-weaving speed, S_{NW}	mph
Level of Service, LOS	F	Maximum weaving length, L_{MAX}	5872 ft

Notes

a. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments".
b. For volumes that exceed the weaving segment capacity, the level of service is "F".

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-26 WB*
Agency or Company	*Atkins*	From/To	*2225- Rem/Avia CD Off to CD On*
Date Performed	*4/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2013*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*3740*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*11*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.948*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*4*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*60.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*60.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1096*	pc/h/ln
S	*60.0*	mph
D = v_p / S	*18.3*	pc/mi/ln
LOS	*C*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-26 WB*
Agency or Company	*Atkins*	From/To	*2225- Rem/Avia CD Off to CD On*
Date Performed	*4/25/2014*	Jurisdiction	
Analysis Time Period	*PM Peak*	Analysis Year	*2013*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*6434*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*9*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.957*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*4*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*60.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*60.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1868*	pc/h/ln
S	*58.7*	mph
D = v_p / S	*31.8*	pc/mi/ln
LOS	*D*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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RAMP ADD OR DROP LANE ANALYSIS (MAINLINE <55 MPH)

ATKINS

General Information

Date Performed:	3/20/2014	Freeway/Direction	I-26 WB C-D
Analysis Year	2013	Junction	WB Off to Remount
Analysis Time Period:	AM Peak	Segment ID	2230
Project Description:	Navy Base ICTF		

Inputs

	Mainline Upstream Ramp	Mainline Downstream Ramp	Ramp
Number of Lanes, N	2	1	1
Free-Flow Speed, FFS (mph)	55	55	45
Volume, V (veh/h)	1,183	713	470
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	2%	2%	2%
%RVs, P_R	0%	0%	0%

Performance Measures

	Upstream of Off-Ramp	Downstream of Off-Ramp	Off-Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.99	0.99	0.99
Demand Flow Rate, v_p (pc/h/ln)	664	800	527
Capacity Flow Rate, c (pc/h/ln)	2,200	2,200	2,100
v/c ratio	0.30	0.36	0.25
Density, D_{MD} (pc/mi/ln)	11.6	14.0	9.2
LOS	B	B	A

Formulas and Reference Material

$$f_{HV} = \frac{1}{1+P_T(E_T-1)+P_R(E_R-1)}$$ HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P}$$ HCM 2010, Equation 11-2

$$D_{MD} = \frac{0.0175*v_f}{N}$$ HCM 2010, Equation 13-26

Ramp Roadways Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

Diverge LOS Thresholds

LOS	Density (pc/mi/ln)
A	≤10
B	>10-20
C	>20-28
D	>28-35
E	>35
F	v/c > 1

Source: HCM 2010, Exhibit 13-2

RAMP ADD OR DROP LANE ANALYSIS (MAINLINE <55 MPH)

ATKINS

General Information

Date Performed:	3/20/2014	Freeway/Direction	I-26 WB C-D
Analysis Year	2013	Junction	WB Off to Remount
Analysis Time Period:	PM Peak	Segment ID	2230
Project Description:	Navy Base ICTF		

Inputs

	Mainline Upstream Ramp	Mainline Downstream Ramp	Ramp
Number of Lanes, N	2	1	1
Free-Flow Speed, FFS (mph)	55	55	45
Volume, V (veh/h)	896	465	431
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	5%	7%	3%
%RVs, P_R	0%	0%	0%

Performance Measures

	Upstream of Off-Ramp	Downstream of Off-Ramp	Off-Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.98	0.97	0.99
Demand Flow Rate, v_p (pc/h/ln)	510	535	486
Capacity Flow Rate, c (pc/h/ln)	2,200	2,200	2,100
v/c ratio	0.23	0.24	0.23
Density, D_{MD} (pc/mi/ln)	8.9	9.4	8.5
LOS	A	A	A

Formulas and Reference Material

$$f_{HV} = \frac{1}{1+P_T(E_T-1)+P_R(E_R-1)}$$ HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P}$$ HCM 2010, Equation 11-2

$$D_{MD} = \frac{0.0175*v_f}{N}$$ HCM 2010, Equation 13-26

Ramp Roadways Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

Diverge LOS Thresholds

LOS	Density (pc/mi/ln)
A	≤10
B	>10-20
C	>20-28
D	>28-35
E	>35
F	v/c > 1

Source: HCM 2010, Exhibit 13-2

BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-26 WB C-D*
Agency or Company	*Atkins*	From/To	*2235-Remount Off to Remount On*
Date Performed	*4/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2013*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*1426*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*2*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.990*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*55.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*55.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*800*	pc/h/ln
S	*55.0*	mph
D = v_p / S	*14.5*	pc/mi/ln
LOS	*B*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-26 WB C-D*
Agency or Company	*Atkins*	From/To	*2235-Remount Off to Remount On*
Date Performed	*4/25/2014*	Jurisdiction	
Analysis Time Period	*PM Peak*	Analysis Year	*2013*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*930*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*7*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.966*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*55.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*55.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*535*	pc/h/ln
S	*55.0*	mph
D = v_p / S	*9.7*	pc/mi/ln
LOS	*A*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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Navy Base ICTF

FREEWAY WEAVING WORKSHEET

General Information

Analyst	AJR
Agency/Company	Atkins
Date Performed	3/20/2014
Analysis Time Period	AM Peak

Site Information

Freeway/Dir of Travel	I-26 WB C-D
Weaving Segment Location	2240 - Remount to Aviation
Analysis Year	2013

Project Description *Navy Base ICTF*

Inputs

Weaving configuration	One-Sided
Weaving number of lanes, N	2
Weaving segment length, L_S	750ft
Freeway free-flow speed, FFS	55 mph
Segment type	C-D Roadway/ Multilane Highways
Freeway minimum speed, S_{MIN}	15
Freeway maximum capacity, C_{IFL}	2250
Terrain type	Level

Conversions to pc/h Under Base Conditions

	V (veh/h)	PHF	Truck (%)	RV (%)	E_T	E_R	f_{HV}	f_p	v (pc/h)
V_{FF}	0	0.90	0	0	1.5	1.2	1.000	1.00	0
V_{RF}	209	0.90	2	0	1.5	1.2	0.990	1.00	235
V_{FR}	713	0.90	9	0	1.5	1.2	0.957	1.00	828
V_{RR}	0	0.90	0	0	1.5	1.2	1.000	1.00	0
V_{NW}	0							V =	1063
V_W	1063								
VR	1.000								

Configuration Characteristics

Minimum maneuver lanes, N_{WL}	2 lc	Minimum weaving lane changes, LC_{MIN}	1063 lc/h
Interchange density, ID	0.8 int/mi	Weaving lane changes, LC_W	1116 lc/h
Minimum RF lane changes, LC_{RF}	1 lc/pc	Non-weaving lane changes, LC_{NW}	21 lc/h
Minimum FR lane changes, LC_{FR}	1 lc/pc	Total lane changes, LC_{ALL}	1137 lc/h
Minimum RR lane changes, LC_{RR}	lc/pc	Non-weaving vehicle index, I_{NW}	0

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment flow rate, v	1063 pc/h	Weaving intensity factor, W	0.314
Weaving segment capacity, c_w	2400 veh/h	Weaving segment speed, S	45.4 mph
Weaving segment v/c ratio	0.443	Average weaving speed, S_W	45.4 mph
Weaving segment density, D	11.7 pc/mi/ln	Average non-weaving speed, S_{NW}	44.8 mph
Level of Service, LOS	A	Maximum weaving length, L_{MAX}	14232 ft

Notes

a. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments".
b. For volumes that exceed the weaving segment capacity, the level of service is "F".

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Navy Base ICTF

FREEWAY WEAVING WORKSHEET

General Information

Analyst	AJR
Agency/Company	Atkins
Date Performed	3/20/2014
Analysis Time Period	PM Peak

Site Information

Freeway/Dir of Travel	I-26 WB C-D
Weaving Segment Location	2240 - Remount to Aviation
Analysis Year	2013

Project Description *Navy Base ICTF*

Inputs

Weaving configuration	One-Sided
Weaving number of lanes, N	2
Weaving segment length, L_S	750ft
Freeway free-flow speed, FFS	55 mph
Segment type	C-D Roadway/ Multilane Highways
Freeway minimum speed, S_{MIN}	15
Freeway maximum capacity, C_{IFL}	2250
Terrain type	Level

Conversions to pc/h Under Base Conditions

	V (veh/h)	PHF	Truck (%)	RV (%)	E_T	E_R	f_{HV}	f_p	v (pc/h)
V_{FF}	0	0.90	0	0	1.5	1.2	1.000	1.00	0
V_{RF}	761	0.90	4	0	1.5	1.2	0.980	1.00	862
V_{FR}	465	0.90	7	0	1.5	1.2	0.966	1.00	535
V_{RR}	0	0.90	0	0	1.5	1.2	1.000	1.00	0
V_{NW}	0							V =	1397
V_W	1397								
VR	1.000								

Configuration Characteristics

Minimum maneuver lanes, N_{WL}	2 lc	Minimum weaving lane changes, LC_{MIN}	1397 lc/h
Interchange density, ID	0.8 int/mi	Weaving lane changes, LC_W	1450 lc/h
Minimum RF lane changes, LC_{RF}	1 lc/pc	Non-weaving lane changes, LC_{NW}	21 lc/h
Minimum FR lane changes, LC_{FR}	1 lc/pc	Total lane changes, LC_{ALL}	1471 lc/h
Minimum RR lane changes, LC_{RR}	lc/pc	Non-weaving vehicle index, I_{NW}	0

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment flow rate, v	1397 pc/h	Weaving intensity factor, W	0.385
Weaving segment capacity, c_w	2400 veh/h	Weaving segment speed, S	43.9 mph
Weaving segment v/c ratio	0.582	Average weaving speed, S_W	43.9 mph
Weaving segment density, D	15.9 pc/mi/ln	Average non-weaving speed, S_{NW}	41.6 mph
Level of Service, LOS	B	Maximum weaving length, L_{MAX}	14232 ft

Notes

a. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments".
b. For volumes that exceed the weaving segment capacity, the level of service is "F".

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-26 WB C-D*
Agency or Company	*Atkins*	From/To	*2245 - Avia Off to Avia EB On*
Date Performed	*4/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2013*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*418*	veh/h	Peak-Hour Factor, PHF	*0.90*	
AADT		veh/day	%Trucks and Buses, P_T	*9*	
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*	
Peak-Hr Direction Prop, D			General Terrain:	*Level*	
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*	

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.957*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*55.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*55.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*243*	pc/h/ln
S	*55.0*	mph
D = v_p / S	*4.4*	pc/mi/ln
LOS	*A*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-26 WB C-D*
Agency or Company	*Atkins*	From/To	*2245 - Avia Off to Avia EB On*
Date Performed	*4/25/2014*	Jurisdiction	
Analysis Time Period	*PM Peak*	Analysis Year	*2013*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*1522*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*4*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.980*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*55.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*55.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*862*	pc/h/ln
S	*55.0*	mph
D = v_p / S	*15.7*	pc/mi/ln
LOS	*B*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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RAMP ADD OR DROP LANE ANALYSIS (MAINLINE <55 MPH)

ATKINS

General Information

Date Performed:	3/20/2014	Freeway/Direction	I-26 WB C-D
Analysis Year	2013	Junction	WB On from Aviation EB
Analysis Time Period:	AM Peak	Segment ID	2250
Project Description:	Navy Base ICTF		

Inputs

	Mainline Upstream Ramp	Mainline Downstream Ramp	Ramp
Number of Lanes, N	1	1	1
Free-Flow Speed, FFS (mph)	55	55	25
Volume, V (veh/h)	209	228	19
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	9%	9%	11%
%RVs, P_R	0%	0%	0%

Performance Measures

	Upstream of Off-Ramp	Downstream of Off-Ramp	Off-Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.96	0.96	0.95
Demand Flow Rate, v_p (pc/h/ln)	243	265	22
Capacity Flow Rate, c (pc/h/ln)	2,200	2,200	1,900
v/c ratio	0.11	0.12	0.01
Density, D_{MD} (pc/mi/ln)	4.3	4.6	0.4
LOS	A	A	A

Formulas and Reference Material

$$f_{HV} = \frac{1}{1+P_T(E_T-1)+P_R(E_R-1)}$$ HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P}$$ HCM 2010, Equation 11-2

$$D_{MD} = \frac{0.0175*v_f}{N}$$ HCM 2010, Equation 13-26

Ramp Roadways Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

Diverge LOS Thresholds

LOS	Density (pc/mi/ln)
A	≤10
B	>10-20
C	>20-28
D	>28-35
E	>35
F	v/c > 1

Source: HCM 2010, Exhibit 13-2

RAMP ADD OR DROP LANE ANALYSIS (MAINLINE <55 MPH)

ATKINS

General Information

Date Performed:	3/20/2014	Freeway/Direction	I-26 WB C-D
Analysis Year	2013	Junction	WB On from Aviation EB
Analysis Time Period:	PM Peak	Segment ID	2250
Project Description:	Navy Base ICTF		

Inputs

	Mainline Upstream Ramp	Mainline Downstream Ramp	Ramp
Number of Lanes, N	1	1	1
Free-Flow Speed, FFS (mph)	55	55	25
Volume, V (veh/h)	761	1,128	367
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	4%	4%	2%
%RVs, P_R	0%	0%	0%

Performance Measures

	Upstream of Off-Ramp	Downstream of Off-Ramp	Off-Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.98	0.98	0.99
Demand Flow Rate, v_p (pc/h/ln)	862	1,278	412
Capacity Flow Rate, c (pc/h/ln)	2,200	2,200	1,900
v/c ratio	0.39	0.58	0.22
Density, D_{MD} (pc/mi/ln)	15.1	22.4	7.2
LOS	B	C	A

Formulas and Reference Material

$$f_{HV} = \frac{1}{1+P_T(E_T-1)+P_R(E_R-1)}$$ HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P}$$ HCM 2010, Equation 11-2

$$D_{MD} = \frac{0.0175*v_f}{N}$$ HCM 2010, Equation 13-26

Ramp Roadways Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

Diverge LOS Thresholds

LOS	Density (pc/mi/ln)
A	≤10
B	>10-20
C	>20-28
D	>28-35
E	>35
F	v/c > 1

Source: HCM 2010, Exhibit 13-2

RAMP ADD OR DROP LANE ANALYSIS (MAINLINE <55 MPH)

ATKINS

General Information

Date Performed:	3/20/2014	Freeway/Direction	I-26 WB C-D
Analysis Year	2013	Junction	WB On from Aviation WB
Analysis Time Period:	AM Peak	Segment ID	2260
Project Description:	Navy Base ICTF		

Inputs

	Mainline Upstream Ramp	Mainline Downstream Ramp	Ramp
Number of Lanes, N	1	1	1
Free-Flow Speed, FFS (mph)	55	55	45
Volume, V (veh/h)	228	295	67
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	9%	11%	15%
%RVs, P_R	0%	0%	0%

Performance Measures

	Upstream of Off-Ramp	Downstream of Off-Ramp	Off-Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.96	0.95	0.93
Demand Flow Rate, v_p (pc/h/ln)	265	346	80
Capacity Flow Rate, c (pc/h/ln)	2,200	2,200	2,100
v/c ratio	0.12	0.16	0.04
Density, D_{MD} (pc/mi/ln)	4.6	6.1	1.4
LOS	A	A	A

Formulas and Reference Material

$$f_{HV} = \frac{1}{1+P_T(E_T-1)+P_R(E_R-1)}$$ HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P}$$ HCM 2010, Equation 11-2

$$D_{MD} = \frac{0.0175*v_f}{N}$$ HCM 2010, Equation 13-26

Ramp Roadways Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

Diverge LOS Thresholds

LOS	Density (pc/mi/ln)
A	≤10
B	>10-20
C	>20-28
D	>28-35
E	>35
F	v/c > 1

Source: HCM 2010, Exhibit 13-2

RAMP ADD OR DROP LANE ANALYSIS (MAINLINE <55 MPH)

ATKINS

General Information

Date Performed:	3/20/2014	Freeway/Direction	I-26 WB C-D
Analysis Year	2013	Junction	WB On from Aviation WB
Analysis Time Period:	PM Peak	Segment ID	2260
Project Description:	Navy Base ICTF		

Inputs

	Mainline Upstream Ramp	Mainline Downstream Ramp	Ramp
Number of Lanes, N	1	1	1
Free-Flow Speed, FFS (mph)	55	55	45
Volume, V (veh/h)	1,128	1,470	342
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	4%	3%	3%
%RVs, P_R	0%	0%	0%

Performance Measures

	Upstream of Off-Ramp	Downstream of Off-Ramp	Off-Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.98	0.99	0.99
Demand Flow Rate, v_p (pc/h/ln)	1,278	1,658	386
Capacity Flow Rate, c (pc/h/ln)	2,200	2,200	2,100
v/c ratio	0.58	0.75	0.18
Density, D_{MD} (pc/mi/ln)	22.4	29.0	6.8
LOS	C	D	A

Formulas and Reference Material

$$f_{HV} = \frac{1}{1+P_T(E_T-1)+P_R(E_R-1)}$$ HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P}$$ HCM 2010, Equation 11-2

$$D_{MD} = \frac{0.0175*v_f}{N}$$ HCM 2010, Equation 13-26

Ramp Roadways Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

Diverge LOS Thresholds

LOS	Density (pc/mi/ln)
A	≤10
B	>10-20
C	>20-28
D	>28-35
E	>35
F	v/c > 1

Source: HCM 2010, Exhibit 13-2

FREEWAY RAMP ADD OR DROP LANE ANALYSIS

ATKINS

General Information

Date Performed:	3/20/2014	Freeway/Direction	I-26 WB
Analysis Year	2013	Junction	From Rem/Aviation C-D
Analysis Time Period:	AM Peak	Segment ID	2270
Project Description:	Navy Base ICTF		

Inputs

	Freeway Upstream of Off-Ramp	Freeway Downstream of Off-Ramp	Off-Ramp
Number of Lanes, N	4	5	1
Free-Flow Speed, FFS (mph)	60	60	55
Volume, V (veh/h)	3,740	4,035	295
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	11%	11%	11%
%RVs, P_R	0%	0%	0%

Performance Measures

	Freeway Upstream Ramp	Freeway Downstream Ramp	Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.95	0.95	0.95
Demand Flow Rate, v_p (pc/h/ln)	1,096	946	346
Capacity Flow Rate, c (pc/h/ln)	2,300	2,300	2,200
v/c ratio	0.48	0.41	0.16
Density, D_{MD} (pc/mi/ln)	19.2	16.6	6.1
LOS	B	B	A

Formulas and Reference Material

$$f_{HV} = \frac{1}{1+P_T(E_T-1)+P_R(E_R-1)}$$ HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P}$$ HCM 2010, Equation 11-2

$$D_{MD} = \frac{0.0175*v_f}{N}$$ HCM 2010, Equation 13-26

Basic Freeway Segments Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
75	2,400
70	2,400
65	2,350
60	2,300
55	2,250

Source: HCM 2010, Exhibit 11-17

Ramp Roadways Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

Diverge LOS Thresholds

LOS	Density (pc/mi/ln)
A	≤10
B	>10-20
C	>20-28
D	>28-35
E	>35
F	v/c > 1

Source: HCM 2010, Exhibit 13-2

FREEWAY RAMP ADD OR DROP LANE ANALYSIS

ATKINS

General Information

Date Performed:	3/20/2014	Freeway/Direction	I-26 WB
Analysis Year	2013	Junction	From Rem/Aviation C-D
Analysis Time Period:	PM Peak	Segment ID	2270
Project Description:	Navy Base ICTF		

Inputs

	Freeway Upstream of Ramp	Freeway Downstream of Ramp	Ramp
Number of Lanes, N	4	5	1
Free-Flow Speed, FFS (mph)	60	60	55
Volume, V (veh/h)	6,434	7,904	1,470
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	9%	8%	3%
%RVs, P_R	0%	0%	0%

Performance Measures

	Freeway Upstream Ramp	Freeway Downstream Ramp	Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.96	0.96	0.99
Demand Flow Rate, v_p (pc/h/ln)	1,868	1,827	1,658
Capacity Flow Rate, c (pc/h/ln)	2,300	2,300	2,200
v/c ratio	0.81	0.79	0.75
Density, D_{MD} (pc/mi/ln)	32.7	32.0	29.0
LOS	D	D	D

Formulas and Reference Material

$$f_{HV} = \frac{1}{1+P_T(E_T-1)+P_R(E_R-1)}$$ HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P}$$ HCM 2010, Equation 11-2

$$D_{MD} = \frac{0.0175*v_f}{N}$$ HCM 2010, Equation 13-26

Basic Freeway Segments Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
75	2,400
70	2,400
65	2,350
60	2,300
55	2,250

Source: HCM 2010, Exhibit 11-17

Ramp Roadways Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

Diverge LOS Thresholds

LOS	Density (pc/mi/ln)
A	≤10
B	>10-20
C	>20-28
D	>28-35
E	>35
F	v/c > 1

Source: HCM 2010, Exhibit 13-2

Appendix E
Traffic Analysis Worksheets

2013 Existing

Interstate 526

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-526 EB
Agency or Company	Atkins	Junction	3010-EB Off to PaulCantrell EB
Date Performed	3/20/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2013

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Freeway Number of Lanes, N	2	Downstream Adj Ramp	
☐ Yes	☐ On	Ramp Number of Lanes, N	1	☐ Yes	☐ On
☑ No	☐ Off	Acceleration Lane Length, L_A		☑ No	☐ Off
L_{up} =	ft	Deceleration Lane Length L_D	340	L_{down} =	ft
V_u =	veh/h	Freeway Volume, V_F	2617	V_D =	veh/h
		Ramp Volume, V_R	22		
		Freeway Free-Flow Speed, S_{FF}	60.0		
		Ramp Free-Flow Speed, S_{FR}	45.0		

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	2617	0.90	Level	3	0	0.985	1.00	2951
Ramp	22	0.90	Level	64	0	0.758	1.00	32
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 1.000 using Equation (Exhibit 13-7)

V_{12} = 2951 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	2951	Exhibit 13-8	4600	No
$V_{FO} = V_F - V_R$	2919	Exhibit 13-8	4600	No
V_R	32	Exhibit 13-10	2100	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	2951	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = 26.6 (pc/mi/ln)

LOS = C (Exhibit 13-2)

Speed Determination

D_s = 0.301 (Exhibit 13-12)

S_R= 54.6 mph (Exhibit 13-12)

S_0= N/A mph (Exhibit 13-12)

S = 54.6 mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-526 EB
Agency or Company	Atkins	Junction	3010-EB Off to PaulCantrell EB
Date Performed	3/20/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2013

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Number of Lanes, N	2	Downstream Adj Ramp	
☐ Yes	☐ On	Acceleration Lane Length, L_A		☐ Yes	☐ On
☑ No	☐ Off	Deceleration Lane Length L_D	340	☑ No	☐ Off
L_{up} =	ft	Freeway Volume, V_F	2524	L_{down} =	ft
V_u =	veh/h	Ramp Volume, V_R	44	V_D =	veh/h
		Freeway Free-Flow Speed, S_{FF}	60.0		
		Ramp Free-Flow Speed, S_{FR}	45.0		

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	2524	0.90	Level	2	0	0.990	1.00	2832
Ramp	44	0.90	Level	9	0	0.957	1.00	51
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 1.000 using Equation (Exhibit 13-7)

V_{12} = 2832 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	2832	Exhibit 13-8	4600	No
$V_{FO} = V_F - V_R$	2781	Exhibit 13-8	4600	No
V_R	51	Exhibit 13-10	2100	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	2832	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = 25.5 (pc/mi/ln)

LOS = C (Exhibit 13-2)

Speed Determination

D_s = 0.303 (Exhibit 13-12)

S_R= 54.6 mph (Exhibit 13-12)

S_0= N/A mph (Exhibit 13-12)

S = 54.6 mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-526 EB
Agency or Company	Atkins	Junction	3020-EB Off to PaulCantrell WB
Date Performed	3/20/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2013

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Freeway Number of Lanes, N	2	Downstream Adj Ramp	
☐ Yes	☐ On	Ramp Number of Lanes, N	1	☐ Yes	☐ On
☑ No	☐ Off	Acceleration Lane Length, L_A		☑ No	☐ Off
L_{up} =	ft	Deceleration Lane Length L_D	600	L_{down} =	ft
V_u =	veh/h	Freeway Volume, V_F	2595	V_D =	veh/h
		Ramp Volume, V_R	166		
		Freeway Free-Flow Speed, S_{FF}	60.0		
		Ramp Free-Flow Speed, S_{FR}	25.0		

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	2595	0.90	Level	3	0	0.985	1.00	2927
Ramp	166	0.90	Level	10	0	0.952	1.00	194
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 1.000 using Equation (Exhibit 13-7)

V_{12} = 2927 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	2927	Exhibit 13-8	4600	No
$V_{FO} = V_F - V_R$	2733	Exhibit 13-8	4600	No
V_R	194	Exhibit 13-10	1900	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	2927	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = 24.0 (pc/mi/ln)

LOS = C (Exhibit 13-2)

Speed Determination

D_s = 0.575 (Exhibit 13-12)

S_R= 49.6 mph (Exhibit 13-12)

S_0= N/A mph (Exhibit 13-12)

S = 49.6 mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-526 EB
Agency or Company	Atkins	Junction	3020-EB Off to PaulCantrell WB
Date Performed	3/20/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2013

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Freeway Number of Lanes, N	2	Downstream Adj Ramp	
☐ Yes	☐ On	Ramp Number of Lanes, N	1	☐ Yes	☐ On
☑ No	☐ Off	Acceleration Lane Length, L_A		☑ No	☐ Off
L_{up} =	ft	Deceleration Lane Length L_D	600	L_{down} =	ft
V_u =	veh/h	Freeway Volume, V_F	2480	V_D =	veh/h
		Ramp Volume, V_R	547		
		Freeway Free-Flow Speed, S_{FF}	60.0		
		Ramp Free-Flow Speed, S_{FR}	25.0		

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	2480	0.90	Level	2	0	0.990	1.00	2783
Ramp	547	0.90	Level	4	0	0.980	1.00	620
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 1.000 using Equation (Exhibit 13-7)

V_{12} = 2783 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	2783	Exhibit 13-8	4600	No
$V_{FO} = V_F - V_R$	2163	Exhibit 13-8	4600	No
V_R	620	Exhibit 13-10	1900	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	2783	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = 22.8 (pc/mi/ln)

LOS = C (Exhibit 13-2)

Speed Determination

D_s = 0.614 (Exhibit 13-12)

S_R= 49.0 mph (Exhibit 13-12)

S_0= N/A mph (Exhibit 13-12)

S = 49.0 mph (Exhibit 13-13)

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-526 EB*
Agency or Company	*Atkins*	From/To	*3025- PaulC WB Off to PaulC On*
Date Performed	*4/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2013*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*2429*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*2*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length	*mi*
			Up/Down %	

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.990*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*60.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*60.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1363*	pc/h/ln
S	*60.0*	mph
D = v_p / S	*22.7*	pc/mi/ln
LOS	*C*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-526 EB*
Agency or Company	*Atkins*	From/To	*3025- PaulC WB Off to PaulC On*
Date Performed	*4/25/2014*	Jurisdiction	
Analysis Time Period	*PM Peak*	Analysis Year	*2013*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*1933*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*2*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.990*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*60.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*60.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1085*	pc/h/ln
S	*60.0*	mph
D = v_p / S	*18.1*	pc/mi/ln
LOS	*C*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-526 EB
Agency or Company	Atkins	Junction	3030-EB On from Paul Cantrell
Date Performed	4/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2013

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Freeway Number of Lanes, N: 2	☐ Yes ☐ On
☑ No ☐ Off	Ramp Number of Lanes, N: 1	☑ No ☐ Off
L_{up} = ft	Acceleration Lane Length, L_A: 850	L_{down} = ft
V_u = veh/h	Deceleration Lane Length L_D:	V_D = veh/h
	Freeway Volume, V_F: 2429	
	Ramp Volume, V_R: 1293	
	Freeway Free-Flow Speed, S_{FF}: 60.0	
	Ramp Free-Flow Speed, S_{FR}: 45.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	2429	0.90	Level	2	0	0.990	1.00	2726
Ramp	1293	0.90	Level	21	0	0.905	1.00	1588
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 1.000 using Equation (Exhibit 13-6)

V_{12} = 2726 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	4314	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	4314	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = 33.1 (pc/mi/ln)

LOS = D (Exhibit 13-2)

Speed Determination

M_S = 0.536 (Exibit 13-11)

S_R= 50.4 mph (Exhibit 13-11)

S_0= N/A mph (Exhibit 13-11)

S = 50.4 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-526 EB
Agency or Company	Atkins	Junction	3030-EB On from Paul Cantrell
Date Performed	4/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2013

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Freeway Number of Lanes, N: 2	☐ Yes ☐ On
☑ No ☐ Off	Ramp Number of Lanes, N: 1	☑ No ☐ Off
L_{up} = ft	Acceleration Lane Length, L_A: 850	L_{down} = ft
V_u = veh/h	Deceleration Lane Length L_D:	V_D = veh/h
	Freeway Volume, V_F: 1933	
	Ramp Volume, V_R: 1133	
	Freeway Free-Flow Speed, S_{FF}: 60.0	
	Ramp Free-Flow Speed, S_{FR}: 45.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	1933	0.90	Level	2	0	0.990	1.00	2169
Ramp	1133	0.90	Level	16	0	0.926	1.00	1360
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 1.000 using Equation (Exhibit 13-6)

V_{12} = 2169 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	3529	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	3529	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = 27.0 (pc/mi/ln)

LOS = C (Exhibit 13-2)

Speed Determination

M_S = 0.377 (Exibit 13-11)

S_R= 53.2 mph (Exhibit 13-11)

S_0= N/A mph (Exhibit 13-11)

S = 53.2 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-526 EB*
Agency or Company	*Atkins*	From/To	*3040 - Paul Cantrell to Leeds*
Date Performed	*4/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2013*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*3722*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*9*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length	*mi*
			Up/Down %	

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.957*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*60.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*60.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*2161*	pc/h/ln
S	*54.3*	mph
D = v_p / S	*39.8*	pc/mi/ln
LOS	*E*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-526 EB*
Agency or Company	*Atkins*	From/To	*3040 - Paul Cantrell to Leeds*
Date Performed	*4/25/2014*	Jurisdiction	
Analysis Time Period	*PM Peak*	Analysis Year	*2013*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*3066*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*7*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length	*mi*
			Up/Down %	

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.966*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*60.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*60.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1763*	pc/h/ln
S	*59.5*	mph
D = v_p / S	*29.6*	pc/mi/ln
LOS	*D*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-526 EB
Agency or Company	Atkins	Junction	3050-EB Off to Leeds
Date Performed	3/20/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2013

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Freeway Number of Lanes, N	2	Downstream Adj Ramp	
☐ Yes	☐ On	Ramp Number of Lanes, N	1	☐ Yes	☐ On
☑ No	☐ Off	Acceleration Lane Length, L_A		☑ No	☐ Off
L_{up} =	ft	Deceleration Lane Length L_D	325	L_{down} =	ft
V_u =	veh/h	Freeway Volume, V_F	3722	V_D =	veh/h
		Ramp Volume, V_R	655		
		Freeway Free-Flow Speed, S_{FF}	60.0		
		Ramp Free-Flow Speed, S_{FR}	45.0		

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	3722	0.90	Level	9	0	0.957	1.00	4322
Ramp	655	0.90	Level	7	0	0.966	1.00	753
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 1.000 using Equation (Exhibit 13-7)

V_{12} = 4322 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	4322	Exhibit 13-8	4600	No
$V_{FO} = V_F - V_R$	3569	Exhibit 13-8	4600	No
V_R	753	Exhibit 13-10	2100	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	4322	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = 38.5 (pc/mi/ln)

LOS = E (Exhibit 13-2)

Speed Determination

D_s = 0.366 (Exhibit 13-12)

S_R= 53.4 mph (Exhibit 13-12)

S_0= N/A mph (Exhibit 13-12)

S = 53.4 mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-526 EB
Agency or Company	Atkins	Junction	3050-EB Off to Leeds
Date Performed	3/20/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2013

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Freeway Number of Lanes, N	2	Downstream Adj Ramp	
☐ Yes	☐ On	Ramp Number of Lanes, N	1	☐ Yes	☐ On
☑ No	☐ Off	Acceleration Lane Length, L_A		☑ No	☐ Off
L_{up} =	ft	Deceleration Lane Length L_D	325	L_{down} =	ft
V_u =	veh/h	Freeway Volume, V_F	3066	V_D =	veh/h
		Ramp Volume, V_R	309		
		Freeway Free-Flow Speed, S_{FF}	60.0		
		Ramp Free-Flow Speed, S_{FR}	45.0		

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	3066	0.90	Level	7	0	0.966	1.00	3526
Ramp	309	0.90	Level	21	0	0.905	1.00	379
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 1.000 using Equation (Exhibit 13-7)

V_{12} = 3526 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	3526	Exhibit 13-8	4600	No
$V_{FO} = V_F - V_R$	3147	Exhibit 13-8	4600	No
V_R	379	Exhibit 13-10	2100	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	3526	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = 31.7 (pc/mi/ln)

LOS = D (Exhibit 13-2)

Speed Determination

D_s = 0.332 (Exhibit 13-12)

S_R= 54.0 mph (Exhibit 13-12)

S_0= N/A mph (Exhibit 13-12)

S = 54.0 mph (Exhibit 13-13)

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-526 EB*
Agency or Company	*Atkins*	From/To	*3055 - Leeds Off to Leeds On*
Date Performed	*4/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2013*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*3067*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*9*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length	*mi*
			Up/Down %	

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.957*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*60.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*60.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1781*	pc/h/ln
S	*59.4*	mph
D = v_p / S	*30.0*	pc/mi/ln
LOS	*D*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-526 EB*
Agency or Company	*Atkins*	From/To	*3055 - Leeds Off to Leeds On*
Date Performed	*4/25/2014*	Jurisdiction	
Analysis Time Period	*PM Peak*	Analysis Year	*2013*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*2757*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*5*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.976*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*60.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*60.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1570*	pc/h/ln
S	*60.0*	mph
D = v_p / S	*26.2*	pc/mi/ln
LOS	*D*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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F-2308

Navy Base ICTF

FREEWAY WEAVING WORKSHEET

General Information

Analyst	AJR
Agency/Company	Atkins
Date Performed	3/20/2014
Analysis Time Period	AM Peak

Site Information

Freeway/Dir of Travel	I-526 EB
Weaving Segment Location	3060 - Leeds to Dorchester
Analysis Year	2013

Project Description *Navy Base ICTF*

Inputs

Weaving configuration	One-Sided
Weaving number of lanes, N	3
Weaving segment length, L_S	2020ft
Freeway free-flow speed, FFS	60 mph
Segment type	Freeway
Freeway minimum speed, S_{MIN}	15
Freeway maximum capacity, C_{IFL}	2300
Terrain type	Level

Conversions to pc/h Under Base Conditions

	V (veh/h)	PHF	Truck (%)	RV (%)	E_T	E_R	f_{HV}	fp	v (pc/h)
V_{FF}	2780	0.90	8	0	1.5	1.2	0.962	1.00	3212
V_{RF}	223	0.90	4	0	1.5	1.2	0.980	1.00	253
V_{FR}	287	0.90	13	0	1.5	1.2	0.939	1.00	340
V_{RR}	23	0.90	9	0	1.5	1.2	0.957	1.00	27
V_{NW}	3239							V =	3832
V_W	593								
VR	0.155								

Configuration Characteristics

Minimum maneuver lanes, N_{WL}	2 lc	Minimum weaving lane changes, LC_{MIN}	593 lc/h
Interchange density, ID	1.0 int/mi	Weaving lane changes, LC_W	846 lc/h
Minimum RF lane changes, LC_{RF}	1 lc/pc	Non-weaving lane changes, LC_{NW}	1184 lc/h
Minimum FR lane changes, LC_{FR}	1 lc/pc	Total lane changes, LC_{ALL}	2030 lc/h
Minimum RR lane changes, LC_{RR}	lc/pc	Non-weaving vehicle index, I_{NW}	654

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment flow rate, v	3832 pc/h	Weaving intensity factor, W	0.227
Weaving segment capacity, c_w	6179 veh/h	Weaving segment speed, S	49.9 mph
Weaving segment v/c ratio	0.596	Average weaving speed, S_W	51.7 mph
Weaving segment density, D	25.6 pc/mi/ln	Average non-weaving speed, S_{NW}	49.6 mph
Level of Service, LOS	C	Maximum weaving length, L_{MAX}	4079 ft

Notes

a. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments".
b. For volumes that exceed the weaving segment capacity, the level of service is "F".

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Navy Base ICTF

FREEWAY WEAVING WORKSHEET

General Information

Analyst	AJR
Agency/Company	Atkins
Date Performed	3/20/2014
Analysis Time Period	PM Peak

Site Information

Freeway/Dir of Travel	I-526 EB
Weaving Segment Location	3060 - Leeds to Dorchester
Analysis Year	2013

Project Description *Navy Base ICTF*

Inputs

Weaving configuration	One-Sided
Weaving number of lanes, N	3
Weaving segment length, L_S	2020ft
Freeway free-flow speed, FFS	60 mph
Segment type	Freeway
Freeway minimum speed, S_{MIN}	15
Freeway maximum capacity, C_{IFL}	2300
Terrain type	Level

Conversions to pc/h Under Base Conditions

	V (veh/h)	PHF	Truck (%)	RV (%)	E_T	E_R	f_{HV}	f_p	v (pc/h)
V_{FF}	2420	0.90	5	0	1.5	1.2	0.976	1.00	2756
V_{RF}	781	0.90	2	0	1.5	1.2	0.990	1.00	876
V_{FR}	337	0.90	10	0	1.5	1.2	0.952	1.00	393
V_{RR}	109	0.90	3	0	1.5	1.2	0.985	1.00	123
V_{NW}	2879							V =	4148
V_W	1269								
VR	0.306								

Configuration Characteristics

Minimum maneuver lanes, N_{WL}	2 lc	Minimum weaving lane changes, LC_{MIN}	1269 lc/h
Interchange density, ID	1.0 int/mi	Weaving lane changes, LC_W	1522 lc/h
Minimum RF lane changes, LC_{RF}	1 lc/pc	Non-weaving lane changes, LC_{NW}	1110 lc/h
Minimum FR lane changes, LC_{FR}	1 lc/pc	Total lane changes, LC_{ALL}	2632 lc/h
Minimum RR lane changes, LC_{RR}	lc/pc	Non-weaving vehicle index, I_{NW}	582

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment flow rate, v	4148 pc/h	Weaving intensity factor, W	0.278
Weaving segment capacity, c_w	5918 veh/h	Weaving segment speed, S	45.9 mph
Weaving segment v/c ratio	0.684	Average weaving speed, S_W	50.2 mph
Weaving segment density, D	30.1 pc/mi/ln	Average non-weaving speed, S_{NW}	44.2 mph
Level of Service, LOS	D	Maximum weaving length, L_{MAX}	5648 ft

Notes

a. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments".
b. For volumes that exceed the weaving segment capacity, the level of service is "F".

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-526 EB*
Agency or Company	*Atkins*	From/To	*3065-Dorches Off to Dorches On*
Date Performed	*4/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2013*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*3003*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*8*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length	*mi*
			Up/Down %	

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.962*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*60.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*60.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1735*	pc/h/ln
S	*59.7*	mph
D = v_p / S	*29.1*	pc/mi/ln
LOS	*D*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-526 EB*
Agency or Company	*Atkins*	From/To	*3065-Dorches Off to Dorches On*
Date Performed	*4/25/2014*	Jurisdiction	
Analysis Time Period	*PM Peak*	Analysis Year	*2013*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*3201*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*4*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length	*mi*
			Up/Down %	

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.980*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*60.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*60.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1814*	pc/h/ln
S	*59.2*	mph
D = v_p / S	*30.7*	pc/mi/ln
LOS	*D*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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Navy Base ICTF

FREEWAY WEAVING WORKSHEET

General Information

Analyst	AJR
Agency/Company	Atkins
Date Performed	3/20/2014
Analysis Time Period	AM Peak

Site Information

Freeway/Dir of Travel	I-526 EB
Weaving Segment Location	3070 - Dorchester to Montague
Analysis Year	2013

Project Description *Navy Base ICTF*

Inputs

Weaving configuration	One-Sided
Weaving number of lanes, N	3
Weaving segment length, L_S	1515ft
Freeway free-flow speed, FFS	60 mph
Segment type	Freeway
Freeway minimum speed, S_{MIN}	15
Freeway maximum capacity, C_{IFL}	2300
Terrain type	Level

Conversions to pc/h Under Base Conditions

	V (veh/h)	PHF	Truck (%)	RV (%)	E_T	E_R	f_{HV}	fp	v (pc/h)
V_{FF}	2515	0.90	8	0	1.5	1.2	0.962	1.00	2906
V_{RF}	471	0.90	19	0	1.5	1.2	0.913	1.00	573
V_{FR}	488	0.90	9	0	1.5	1.2	0.957	1.00	567
V_{RR}	91	0.90	21	0	1.5	1.2	0.905	1.00	112
V_{NW}	3018							V =	4158
V_W	1140								
VR	0.274								

Configuration Characteristics

Minimum maneuver lanes, N_{WL}	2 lc	Minimum weaving lane changes, LC_{MIN}	1140 lc/h
Interchange density, ID	0.8 int/mi	Weaving lane changes, LC_W	1336 lc/h
Minimum RF lane changes, LC_{RF}	1 lc/pc	Non-weaving lane changes, LC_{NW}	865 lc/h
Minimum FR lane changes, LC_{FR}	1 lc/pc	Total lane changes, LC_{ALL}	2201 lc/h
Minimum RR lane changes, LC_{RR}	lc/pc	Non-weaving vehicle index, I_{NW}	366

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment flow rate, v	4158 pc/h	Weaving intensity factor, W	0.303
Weaving segment capacity, c_w	5798 veh/h	Weaving segment speed, S	46.3 mph
Weaving segment v/c ratio	0.690	Average weaving speed, S_W	49.5 mph
Weaving segment density, D	30.0 pc/mi/ln	Average non-weaving speed, S_{NW}	45.1 mph
Level of Service, LOS	D	Maximum weaving length, L_{MAX}	5308 ft

Notes

a. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments".
b. For volumes that exceed the weaving segment capacity, the level of service is "F".

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Navy Base ICTF

FREEWAY WEAVING WORKSHEET

General Information

Analyst	AJR
Agency/Company	Atkins
Date Performed	3/20/2014
Analysis Time Period	PM Peak

Site Information

Freeway/Dir of Travel	I-526 EB
Weaving Segment Location	3070 - Dorchester to Montague
Analysis Year	2013

Project Description *Navy Base ICTF*

Inputs

Weaving configuration	One-Sided
Weaving number of lanes, N	3
Weaving segment length, L_S	1515ft
Freeway free-flow speed, FFS	60 mph
Segment type	Freeway
Freeway minimum speed, S_{MIN}	15
Freeway maximum capacity, C_{IFL}	2300
Terrain type	Level

Conversions to pc/h Under Base Conditions

	V (veh/h)	PHF	Truck (%)	RV (%)	E_T	E_R	f_{HV}	fp	v (pc/h)
V_{FF}	2569	0.90	4	0	1.5	1.2	0.980	1.00	2912
V_{RF}	681	0.90	12	0	1.5	1.2	0.943	1.00	802
V_{FR}	632	0.90	4	0	1.5	1.2	0.980	1.00	716
V_{RR}	167	0.90	12	0	1.5	1.2	0.943	1.00	197
V_{NW}	3109							V =	4627
V_W	1518								
VR	0.328								

Configuration Characteristics

Minimum maneuver lanes, N_{WL}	2 lc	Minimum weaving lane changes, LC_{MIN}	1518 lc/h
Interchange density, ID	0.8 int/mi	Weaving lane changes, LC_W	1714 lc/h
Minimum RF lane changes, LC_{RF}	1 lc/pc	Non-weaving lane changes, LC_{NW}	884 lc/h
Minimum FR lane changes, LC_{FR}	1 lc/pc	Total lane changes, LC_{ALL}	2598 lc/h
Minimum RR lane changes, LC_{RR}	lc/pc	Non-weaving vehicle index, I_{NW}	377

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment flow rate, v	4627 pc/h	Weaving intensity factor, W	0.346
Weaving segment capacity, c_w	5782 veh/h	Weaving segment speed, S	43.7 mph
Weaving segment v/c ratio	0.785	Average weaving speed, S_W	48.4 mph
Weaving segment density, D	35.3 pc/mi/ln	Average non-weaving speed, S_{NW}	41.7 mph
Level of Service, LOS	E	Maximum weaving length, L_{MAX}	5887 ft

Notes

a. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments".
b. For volumes that exceed the weaving segment capacity, the level of service is "F".

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-526 EB*
Agency or Company	*Atkins*	From/To	*3080-Montague to International*
Date Performed	*4/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2013*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*2986*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*10*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length	*mi*
			Up/Down %	

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.952*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*60.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*60.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1742*	pc/h/ln
S	*59.6*	mph
D = v_p / S	*29.2*	pc/mi/ln
LOS	*D*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-526 EB*
Agency or Company	*Atkins*	From/To	*3080-Montague to International*
Date Performed	*4/25/2014*	Jurisdiction	
Analysis Time Period	*PM Peak*	Analysis Year	*2013*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*3250*	veh/h	Peak-Hour Factor, PHF	*0.90*	
AADT		veh/day	%Trucks and Buses, P_T	*6*	
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*	
Peak-Hr Direction Prop, D			General Terrain:	*Level*	
DDHV = AADT x K x D		veh/h	Grade % Length	*mi*	
			Up/Down %		

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.971*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*60.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*60.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1860*	pc/h/ln
S	*58.8*	mph
D = v_p / S	*31.6*	pc/mi/ln
LOS	*D*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-526 EB
Agency or Company	Atkins	Junction	3090-EB Off to InternationalWB
Date Performed	3/20/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2013

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Freeway Number of Lanes, N	2	Downstream Adj Ramp	
☐ Yes	☐ On	Ramp Number of Lanes, N	1	☐ Yes	☐ On
☑ No	☐ Off	Acceleration Lane Length, L_A		☑ No	☐ Off
L_{up} =	ft	Deceleration Lane Length L_D	700	L_{down} =	ft
V_u =	veh/h	Freeway Volume, V_F	2986	V_D =	veh/h
		Ramp Volume, V_R	408		
		Freeway Free-Flow Speed, S_{FF}	60.0		
		Ramp Free-Flow Speed, S_{FR}	25.0		

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	2986	0.90	Level	10	0	0.952	1.00	3484
Ramp	408	0.90	Level	8	0	0.962	1.00	471
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 1.000 using Equation (Exhibit 13-7)

V_{12} = 3484 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	3484	Exhibit 13-8	4600	No
$V_{FO} = V_F - V_R$	3013	Exhibit 13-8	4600	No
V_R	471	Exhibit 13-10	1900	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	3484	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = 27.9 (pc/mi/ln)

LOS = C (Exhibit 13-2)

Speed Determination

D_s = 0.600 (Exhibit 13-12)

S_R= 49.2 mph (Exhibit 13-12)

S_0= N/A mph (Exhibit 13-12)

S = 49.2 mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-526 EB
Agency or Company	Atkins	Junction	3090-EB Off to InternationalWB
Date Performed	3/20/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2013

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp

☐ Yes ☐ On

☑ No ☐ Off

L_{up} = ft

V_u = veh/h

Freeway Number of Lanes, N	2
Ramp Number of Lanes, N	1
Acceleration Lane Length, L_A	
Deceleration Lane Length L_D	700
Freeway Volume, V_F	3250
Ramp Volume, V_R	419
Freeway Free-Flow Speed, S_{FF}	60.0
Ramp Free-Flow Speed, S_{FR}	25.0

Downstream Adj Ramp

☐ Yes ☐ On

☑ No ☐ Off

L_{down} = ft

V_D = veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	3250	0.90	Level	6	0	0.971	1.00	3719
Ramp	419	0.90	Level	6	0	0.971	1.00	480
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 1.000 using Equation (Exhibit 13-7)

V_{12} = 3719 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	3719	Exhibit 13-8	4600	No
$V_{FO} = V_F - V_R$	3239	Exhibit 13-8	4600	No
V_R	480	Exhibit 13-10	1900	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	3719	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = 29.9 (pc/mi/ln)

LOS = D (Exhibit 13-2)

Speed Determination

D_s = 0.601 (Exhibit 13-12)

S_R= 49.2 mph (Exhibit 13-12)

S_0= N/A mph (Exhibit 13-12)

S = 49.2 mph (Exhibit 13-13)

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-526 EB*
Agency or Company	*Atkins*	From/To	*3095- Inter WB Off to Inter On*
Date Performed	*4/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2013*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*2578*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*10*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length	*mi*
			Up/Down %	

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.952*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*60.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*60.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1504*	pc/h/ln
S	*60.0*	mph
D = v_p / S	*25.1*	pc/mi/ln
LOS	*C*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-526 EB*
Agency or Company	*Atkins*	From/To	*3095- Inter WB Off to Inter On*
Date Performed	*4/25/2014*	Jurisdiction	
Analysis Time Period	*PM Peak*	Analysis Year	*2013*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*2831*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*6*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length	*mi*
			Up/Down %	

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.971*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*60.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*60.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1620*	pc/h/ln
S	*60.0*	mph
D = v_p / S	*27.0*	pc/mi/ln
LOS	*D*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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Navy Base ICTF

FREEWAY WEAVING WORKSHEET

General Information

Analyst	AJR
Agency/Company	Atkins
Date Performed	3/20/2014
Analysis Time Period	AM Peak

Site Information

Freeway/Dir of Travel	I-526 EB
Weaving Segment Location	3100 - International to I-26
Analysis Year	2013

Project Description *Navy Base ICTF*

Inputs

Weaving configuration	One-Sided
Weaving number of lanes, N	3
Weaving segment length, L_S	2025ft
Freeway free-flow speed, FFS	55 mph
Segment type	Freeway
Freeway minimum speed, S_{MIN}	15
Freeway maximum capacity, C_{IFL}	2250
Terrain type	Level

Conversions to pc/h Under Base Conditions

	V (veh/h)	PHF	Truck (%)	RV (%)	E_T	E_R	f_{HV}	fp	v (pc/h)
V_{FF}	1238	0.90	12	0	1.5	1.2	0.943	1.00	1458
V_{RF}	442	0.90	4	0	1.5	1.2	0.980	1.00	501
V_{FR}	1340	0.90	8	0	1.5	1.2	0.962	1.00	1548
V_{RR}	479	0.90	3	0	1.5	1.2	0.985	1.00	540
V_{NW}	1998							V =	4047
V_W	2049								
VR	0.506								

Configuration Characteristics

Minimum maneuver lanes, N_{WL}	3 lc
Interchange density, ID	1.0 int/mi
Minimum RF lane changes, LC_{RF}	1 lc/pc
Minimum FR lane changes, LC_{FR}	0 lc/pc
Minimum RR lane changes, LC_{RR}	lc/pc
Minimum weaving lane changes, LC_{MIN}	501 lc/h
Weaving lane changes, LC_W	755 lc/h
Non-weaving lane changes, LC_{NW}	931 lc/h
Total lane changes, LC_{ALL}	1686 lc/h
Non-weaving vehicle index, I_{NW}	405

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment flow rate, v	4047 pc/h
Weaving segment capacity, c_w	5434 veh/h
Weaving segment v/c ratio	0.703
Weaving segment density, D	28.9 pc/mi/ln
Level of Service, LOS	D
Weaving intensity factor, W	0.196
Weaving segment speed, S	46.6 mph
Average weaving speed, S_W	48.5 mph
Average non-weaving speed, S_{NW}	44.9 mph
Maximum weaving length, L_{MAX}	6334 ft

Notes

a. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments".
b. For volumes that exceed the weaving segment capacity, the level of service is "F".

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Navy Base ICTF

FREEWAY WEAVING WORKSHEET

General Information

Analyst	AJR
Agency/Company	Atkins
Date Performed	3/20/2014
Analysis Time Period	PM Peak

Site Information

Freeway/Dir of Travel	I-526 EB
Weaving Segment Location	3100 - International to I-26
Analysis Year	2013

Project Description *Navy Base ICTF*

Inputs

Weaving configuration	One-Sided	Segment type	Freeway
Weaving number of lanes, N	3	Freeway minimum speed, S_{MIN}	15
Weaving segment length, L_S	2025ft	Freeway maximum capacity, C_{IFL}	2250
Freeway free-flow speed, FFS	55 mph	Terrain type	Level

Conversions to pc/h Under Base Conditions

	V (veh/h)	PHF	Truck (%)	RV (%)	E_T	E_R	f_{HV}	fp	v (pc/h)
V_{FF}	1415	0.90	2	0	1.5	1.2	0.990	1.00	1588
V_{RF}	686	0.90	2	0	1.5	1.2	0.990	1.00	770
V_{FR}	1416	0.90	9	0	1.5	1.2	0.957	1.00	1644
V_{RR}	686	0.90	6	0	1.5	1.2	0.971	1.00	785
V_{NW}	2373							V =	4787
V_W	2414								
VR	0.504								

Configuration Characteristics

Minimum maneuver lanes, N_{WL}	3 lc	Minimum weaving lane changes, LC_{MIN}	770 lc/h
Interchange density, ID	1.0 int/mi	Weaving lane changes, LC_W	1024 lc/h
Minimum RF lane changes, LC_{RF}	1 lc/pc	Non-weaving lane changes, LC_{NW}	1009 lc/h
Minimum FR lane changes, LC_{FR}	0 lc/pc	Total lane changes, LC_{ALL}	2033 lc/h
Minimum RR lane changes, LC_{RR}	lc/pc	Non-weaving vehicle index, I_{NW}	481

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment flow rate, v	4787 pc/h	Weaving intensity factor, W	0.227
Weaving segment capacity, c_w	5709 veh/h	Weaving segment speed, S	44.5 mph
Weaving segment v/c ratio	0.830	Average weaving speed, S_W	47.6 mph
Weaving segment density, D	35.8 pc/mi/ln	Average non-weaving speed, S_{NW}	41.8 mph
Level of Service, LOS	E	Maximum weaving length, L_{MAX}	6311 ft

Notes

a. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments".
b. For volumes that exceed the weaving segment capacity, the level of service is "F".

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-526 EB*
Agency or Company	*Atkins*	From/To	*3105-I-26 Off to I-26 EB CD On*
Date Performed	*4/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2013*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*1680*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*10*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length	*mi*
			Up/Down %	

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.952*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*55.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*55.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*980*	pc/h/ln
S	*55.0*	mph
D = v_p / S	*17.8*	pc/mi/ln
LOS	*B*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-526 EB*
Agency or Company	*Atkins*	From/To	*3105-I-26 Off to I-26 EB CD On*
Date Performed	*4/25/2014*	Jurisdiction	
Analysis Time Period	*PM Peak*	Analysis Year	*2013*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*2101*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*2*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length	*mi*
			Up/Down %	

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.990*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*55.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*55.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1179*	pc/h/ln
S	*55.0*	mph
D = v_p / S	*21.4*	pc/mi/ln
LOS	*C*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-526 EB
Agency or Company	Atkins	Junction	3110-EB On from I-26 EB
Date Performed	4/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2013

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Freeway Number of Lanes, N: 2	☐ Yes ☐ On
☑ No ☐ Off	Ramp Number of Lanes, N: 1	☑ No ☐ Off
L_{up} = ft	Acceleration Lane Length, L_A: 625	L_{down} = ft
V_u = veh/h	Deceleration Lane Length L_D:	V_D = veh/h
	Freeway Volume, V_F: 1680	
	Ramp Volume, V_R: 1174	
	Freeway Free-Flow Speed, S_{FF}: 55.0	
	Ramp Free-Flow Speed, S_{FR}: 25.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	1680	0.90	Level	10	0	0.952	1.00	1960
Ramp	1174	0.90	Level	29	0	0.873	1.00	1494
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 1.000 using Equation (Exhibit 13-6)

V_{12} = 1960 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	3454	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	3454	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = 27.8 (pc/mi/ln)

LOS = C (Exhibit 13-2)

Speed Determination

M_S = 0.413 (Exibit 13-11)

S_R= 49.6 mph (Exhibit 13-11)

S_0= N/A mph (Exhibit 13-11)

S = 49.6 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-526 EB
Agency or Company	Atkins	Junction	3110-EB On from I-26 EB
Date Performed	4/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2013

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Freeway Number of Lanes, N: 2	☐ Yes ☐ On
☑ No ☐ Off	Ramp Number of Lanes, N: 1	☑ No ☐ Off
L_{up} = ft	Acceleration Lane Length, L_A: 625	L_{down} = ft
V_u = veh/h	Deceleration Lane Length L_D:	V_D = veh/h
	Freeway Volume, V_F: 2101	
	Ramp Volume, V_R: 960	
	Freeway Free-Flow Speed, S_{FF}: 55.0	
	Ramp Free-Flow Speed, S_{FR}: 25.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	2101	0.90	Level	2	0	0.990	1.00	2358
Ramp	960	0.90	Level	17	0	0.922	1.00	1157
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 1.000 using Equation (Exhibit 13-6)

V_{12} = 2358 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	3515	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	3515	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = 28.4 (pc/mi/ln)

LOS = D (Exhibit 13-2)

Speed Determination

M_S = 0.421 (Exibit 13-11)

S_R= 49.5 mph (Exhibit 13-11)

S_0= N/A mph (Exhibit 13-11)

S = 49.5 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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Navy Base ICTF

FREEWAY WEAVING WORKSHEET

General Information

Analyst	AJR
Agency/Company	Atkins
Date Performed	3/20/2014
Analysis Time Period	AM Peak

Site Information

Freeway/Dir of Travel	I-526 EB
Weaving Segment Location	3120 - I-26 WB to Rivers Ave
Analysis Year	2013

Project Description *Navy Base ICTF*

Inputs

Weaving configuration	One-Sided
Weaving number of lanes, N	3
Weaving segment length, L_S	1615ft
Freeway free-flow speed, FFS	55 mph
Segment type	Freeway
Freeway minimum speed, S_{MIN}	15
Freeway maximum capacity, C_{IFL}	2250
Terrain type	Level

Conversions to pc/h Under Base Conditions

	V (veh/h)	PHF	Truck (%)	RV (%)	E_T	E_R	f_{HV}	fp	v (pc/h)
V_{FF}	2704	0.90	18	0	1.5	1.2	0.917	1.00	3275
V_{RF}	464	0.90	13	0	1.5	1.2	0.939	1.00	549
V_{FR}	150	0.90	21	0	1.5	1.2	0.905	1.00	184
V_{RR}	26	0.90	15	0	1.5	1.2	0.930	1.00	31
V_{NW}	3306							V =	4039
V_W	733								
VR	0.181								

Configuration Characteristics

Minimum maneuver lanes, N_{WL}	2 lc	Minimum weaving lane changes, LC_{MIN}	733 lc/h
Interchange density, ID	1.2 int/mi	Weaving lane changes, LC_W	972 lc/h
Minimum RF lane changes, LC_{RF}	1 lc/pc	Non-weaving lane changes, LC_{NW}	979 lc/h
Minimum FR lane changes, LC_{FR}	1 lc/pc	Total lane changes, LC_{ALL}	1951 lc/h
Minimum RR lane changes, LC_{RR}	lc/pc	Non-weaving vehicle index, I_{NW}	641

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment flow rate, v	4039 pc/h	Weaving intensity factor, W	0.262
Weaving segment capacity, c_w	5617 veh/h	Weaving segment speed, S	43.8 mph
Weaving segment v/c ratio	0.660	Average weaving speed, S_W	46.7 mph
Weaving segment density, D	30.7 pc/mi/ln	Average non-weaving speed, S_{NW}	43.3 mph
Level of Service, LOS	D	Maximum weaving length, L_{MAX}	4348 ft

Notes

a. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments".
b. For volumes that exceed the weaving segment capacity, the level of service is "F".

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Navy Base ICTF

FREEWAY WEAVING WORKSHEET

General Information

Analyst	AJR
Agency/Company	Atkins
Date Performed	3/20/2014
Analysis Time Period	PM Peak

Site Information

Freeway/Dir of Travel	I-526 EB
Weaving Segment Location	3120 - I-26 WB to Rivers Ave
Analysis Year	2013

Project Description *Navy Base ICTF*

Inputs

Weaving configuration	One-Sided
Weaving number of lanes, N	3
Weaving segment length, L_S	1615ft
Freeway free-flow speed, FFS	55 mph
Segment type	Freeway
Freeway minimum speed, S_{MIN}	15
Freeway maximum capacity, C_{IFL}	2250
Terrain type	Level

Conversions to pc/h Under Base Conditions

	V (veh/h)	PHF	Truck (%)	RV (%)	E_T	E_R	f_{HV}	fp	v (pc/h)
V_{FF}	2782	0.90	6	0	1.5	1.2	0.971	1.00	3184
V_{RF}	401	0.90	12	0	1.5	1.2	0.943	1.00	472
V_{FR}	279	0.90	11	0	1.5	1.2	0.948	1.00	327
V_{RR}	40	0.90	20	0	1.5	1.2	0.909	1.00	49
V_{NW}	3233							V =	4032
V_W	799								
VR	0.198								

Configuration Characteristics

Minimum maneuver lanes, N_{WL}	2 lc	Minimum weaving lane changes, LC_{MIN}	799 lc/h
Interchange density, ID	1.2 int/mi	Weaving lane changes, LC_W	1038 lc/h
Minimum RF lane changes, LC_{RF}	1 lc/pc	Non-weaving lane changes, LC_{NW}	964 lc/h
Minimum FR lane changes, LC_{FR}	1 lc/pc	Total lane changes, LC_{ALL}	2002 lc/h
Minimum RR lane changes, LC_{RR}	lc/pc	Non-weaving vehicle index, I_{NW}	627

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment flow rate, v	4032 pc/h	Weaving intensity factor, W	0.268
Weaving segment capacity, c_w	5907 veh/h	Weaving segment speed, S	43.5 mph
Weaving segment v/c ratio	0.663	Average weaving speed, S_W	46.6 mph
Weaving segment density, D	30.9 pc/mi/ln	Average non-weaving speed, S_{NW}	42.8 mph
Level of Service, LOS	D	Maximum weaving length, L_{MAX}	4517 ft

Notes

a. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments".
b. For volumes that exceed the weaving segment capacity, the level of service is "F".

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-526 EB
Agency or Company	Atkins	Junction	3130-EB Off to Rivers NB
Date Performed	3/20/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2013

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Freeway Number of Lanes, N	2	Downstream Adj Ramp	
☐ Yes	☐ On	Ramp Number of Lanes, N	1	☐ Yes	☐ On
☑ No	☐ Off	Acceleration Lane Length, L_A		☑ No	☐ Off
L_{up} =	ft	Deceleration Lane Length L_D	800	L_{down} =	ft
V_u =	veh/h	Freeway Volume, V_F	3168	V_D =	veh/h
		Ramp Volume, V_R	136		
		Freeway Free-Flow Speed, S_{FF}	55.0		
		Ramp Free-Flow Speed, S_{FR}	25.0		

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	3168	0.90	Level	17	0	0.922	1.00	3819
Ramp	136	0.90	Level	27	0	0.881	1.00	172
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 1.000 using Equation (Exhibit 13-7)

V_{12} = 3819 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	3819	Exhibit 13-8	4500	No
$V_{FO} = V_F - V_R$	3647	Exhibit 13-8	4500	No
V_R	172	Exhibit 13-10	1900	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	3819	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = 29.9 (pc/mi/ln)

LOS = D (Exhibit 13-2)

Speed Determination

D_s = 0.573 (Exhibit 13-12)

S_R= 47.5 mph (Exhibit 13-12)

S_0= N/A mph (Exhibit 13-12)

S = 47.5 mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-526 EB
Agency or Company	Atkins	Junction	3130-EB Off to Rivers NB
Date Performed	3/20/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2013

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp

☐ Yes ☐ On

☑ No ☐ Off

L_{up} = ft

V_u = veh/h

Freeway Number of Lanes, N	2
Ramp Number of Lanes, N	1
Acceleration Lane Length, L_A	
Deceleration Lane Length L_D	800
Freeway Volume, V_F	3183
Ramp Volume, V_R	320
Freeway Free-Flow Speed, S_{FF}	55.0
Ramp Free-Flow Speed, S_{FR}	25.0

Downstream Adj Ramp

☐ Yes ☐ On

☑ No ☐ Off

L_{down} = ft

V_D = veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	3183	0.90	Level	7	0	0.966	1.00	3660
Ramp	320	0.90	Level	10	0	0.952	1.00	373
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 1.000 using Equation (Exhibit 13-7)

V_{12} = 3660 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	3660	Exhibit 13-8	4500	No
$V_{FO} = V_F - V_R$	3287	Exhibit 13-8	4500	No
V_R	373	Exhibit 13-10	1900	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	3660	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = 28.5 (pc/mi/ln)

LOS = D (Exhibit 13-2)

Speed Determination

D_s = 0.592 (Exhibit 13-12)

S_R= 47.3 mph (Exhibit 13-12)

S_0= N/A mph (Exhibit 13-12)

S = 47.3 mph (Exhibit 13-13)

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-526 EB*
Agency or Company	*Atkins*	From/To	*3135-RiversNB Off to Rivers On*
Date Performed	*4/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2013*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*3032*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*17*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length	*mi*
			Up/Down %	

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.922*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*55.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*55.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1828*	pc/h/ln
S	*55.0*	mph
D = v_p / S	*33.2*	pc/mi/ln
LOS	*D*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-526 EB*
Agency or Company	*Atkins*	From/To	*3135-RiversNB Off to Rivers On*
Date Performed	*4/25/2014*	Jurisdiction	
Analysis Time Period	*PM Peak*	Analysis Year	*2013*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*2863*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*7*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length	*mi*
			Up/Down %	

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.966*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*55.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*55.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1646*	pc/h/ln
S	*55.0*	mph
D = v_p / S	*29.9*	pc/mi/ln
LOS	*D*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-526 EB
Agency or Company	Atkins	Junction	3140-EB On from Rivers
Date Performed	4/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2013

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Freeway Number of Lanes, N: 2	☐ Yes ☐ On
☑ No ☐ Off	Ramp Number of Lanes, N: 1	☑ No ☐ Off
L_{up} = ft	Acceleration Lane Length, L_A: 825	L_{down} = ft
V_u = veh/h	Deceleration Lane Length L_D:	V_D = veh/h
	Freeway Volume, V_F: 3032	
	Ramp Volume, V_R: 465	
	Freeway Free-Flow Speed, S_{FF}: 55.0	
	Ramp Free-Flow Speed, S_{FR}: 45.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	3032	0.90	Level	17	0	0.922	1.00	3655
Ramp	465	0.90	Level	3	0	0.985	1.00	524
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 1.000 using Equation (Exhibit 13-6)

V_{12} = 3655 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	4179	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	4179	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = 32.7 (pc/mi/ln)

LOS = D (Exhibit 13-2)

Speed Determination

M_S = 0.501 (Exibit 13-11)

S_R= 48.5 mph (Exhibit 13-11)

S_0= N/A mph (Exhibit 13-11)

S = 48.5 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-526 EB
Agency or Company	Atkins	Junction	3140-EB On from Rivers
Date Performed	4/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2013

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Freeway Number of Lanes, N: 2	☐ Yes ☐ On
☑ No ☐ Off	Ramp Number of Lanes, N: 1	☑ No ☐ Off
L_{up} = ft	Acceleration Lane Length, L_A: 825	L_{down} = ft
V_u = veh/h	Deceleration Lane Length L_D:	V_D = veh/h
	Freeway Volume, V_F: 2863	
	Ramp Volume, V_R: 420	
	Freeway Free-Flow Speed, S_{FF}: 55.0	
	Ramp Free-Flow Speed, S_{FR}: 45.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	2863	0.90	Level	7	0	0.966	1.00	3292
Ramp	420	0.90	Level	2	0	0.990	1.00	471
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 1.000 using Equation (Exhibit 13-6)

V_{12} = 3292 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	3763	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	3763	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = 29.4 (pc/mi/ln)

LOS = D (Exhibit 13-2)

Speed Determination

M_S = 0.415 (Exibit 13-11)

S_R= 49.6 mph (Exhibit 13-11)

S_0= N/A mph (Exhibit 13-11)

S = 49.6 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-526 EB*
Agency or Company	*Atkins*	From/To	*3150-Rivers to Rhett*
Date Performed	*4/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2013*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*3497*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*15*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.930*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*60.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*60.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*2088*	pc/h/ln
S	*55.7*	mph
D = v_p / S	*37.5*	pc/mi/ln
LOS	*E*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-526 EB*
Agency or Company	*Atkins*	From/To	*3150-Rivers to Rhett*
Date Performed	*4/25/2014*	Jurisdiction	
Analysis Time Period	*PM Peak*	Analysis Year	*2013*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs				
Volume, V	*3283*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*6*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.971*

Speed Inputs			Calc Speed Adj and FFS		
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f_{LW}		mph
Number of Lanes, N	*2*		f_{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	*60.0*	mph	FFS	*60.0*	mph
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures			Design (N)	
Operational (LOS)			Design (N)	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1879*	pc/h/ln	Design LOS	
S	*58.6*	mph	v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h/ln
D = v_p / S	*32.1*	pc/mi/ln	S	mph
LOS	*D*		D = v_p / S	pc/mi/ln
			Required Number of Lanes, N	

Glossary		Factor Location	
N - Number of lanes	S - Speed	E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
V - Hourly volume	D - Density	E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 11-18	TRD - Page 11-11
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 11-2, 11-3	
DDHV - Directional design hour volume			

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-526 EB
Agency or Company	Atkins	Junction	3160-EB Off to Rhett
Date Performed	3/20/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2013

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Freeway Number of Lanes, N	2	Downstream Adj Ramp	
☐ Yes	☐ On	Ramp Number of Lanes, N	1	☐ Yes	☐ On
☑ No	☐ Off	Acceleration Lane Length, L_A		☑ No	☐ Off
L_{up} =	ft	Deceleration Lane Length L_D	225	L_{down} =	ft
V_u =	veh/h	Freeway Volume, V_F	3497	V_D =	veh/h
		Ramp Volume, V_R	455		
		Freeway Free-Flow Speed, S_{FF}	60.0		
		Ramp Free-Flow Speed, S_{FR}	45.0		

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	3497	0.90	Level	15	0	0.930	1.00	4177
Ramp	455	0.90	Level	9	0	0.957	1.00	528
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 1.000 using Equation (Exhibit 13-7)

V_{12} = 4177 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	4177	Exhibit 13-8	4600	No
$V_{FO} = V_F - V_R$	3649	Exhibit 13-8	4600	No
V_R	528	Exhibit 13-10	2100	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	4177	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = 38.1 (pc/mi/ln)

LOS = E (Exhibit 13-2)

Speed Determination

D_s = 0.346 (Exhibit 13-12)

S_R= 53.8 mph (Exhibit 13-12)

S_0= N/A mph (Exhibit 13-12)

S = 53.8 mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-526 EB
Agency or Company	Atkins	Junction	3160-EB Off to Rhett
Date Performed	3/20/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2013

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Freeway Number of Lanes, N	2	Downstream Adj Ramp	
☐ Yes	☐ On	Ramp Number of Lanes, N	1	☐ Yes	☐ On
☑ No	☐ Off	Acceleration Lane Length, L_A		☑ No	☐ Off
L_{up} =	ft	Deceleration Lane Length L_D	225	L_{down} =	ft
V_u =	veh/h	Freeway Volume, V_F	3283	V_D =	veh/h
		Ramp Volume, V_R	672		
		Freeway Free-Flow Speed, S_{FF}	60.0		
		Ramp Free-Flow Speed, S_{FR}	45.0		

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	3283	0.90	Level	6	0	0.971	1.00	3757
Ramp	672	0.90	Level	4	0	0.980	1.00	762
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 1.000 using Equation (Exhibit 13-7)

V_{12} = 3757 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	3757	Exhibit 13-8	4600	No
$V_{FO} = V_F - V_R$	2995	Exhibit 13-8	4600	No
V_R	762	Exhibit 13-10	2100	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	3757	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = 34.5 (pc/mi/ln)

LOS = D (Exhibit 13-2)

Speed Determination

D_s = 0.367 (Exhibit 13-12)

S_R= 53.4 mph (Exhibit 13-12)

S_0= N/A mph (Exhibit 13-12)

S = 53.4 mph (Exhibit 13-13)

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-526 EB*
Agency or Company	*Atkins*	From/To	*3165 - Rhett Off to Rhett On*
Date Performed	*4/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2013*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*3042*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*16*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length	*mi*
			Up/Down %	

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.926*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*60.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*60.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1825*	pc/h/ln
S	*59.1*	mph
D = v_p / S	*30.9*	pc/mi/ln
LOS	*D*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-526 EB*
Agency or Company	*Atkins*	From/To	*3165 - Rhett Off to Rhett On*
Date Performed	*4/25/2014*	Jurisdiction	
Analysis Time Period	*PM Peak*	Analysis Year	*2013*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*2611*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*7*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length	*mi*
			Up/Down %	

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.966*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*60.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*60.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1501*	pc/h/ln
S	*60.0*	mph
D = v_p / S	*25.0*	pc/mi/ln
LOS	*C*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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F-2340

Navy Base ICTF

FREEWAY WEAVING WORKSHEET

General Information

Analyst	AJR
Agency/Company	Atkins
Date Performed	3/20/2014
Analysis Time Period	AM Peak

Site Information

Freeway/Dir of Travel	I-526 EB
Weaving Segment Location	3170 - Rhett to Virginia
Analysis Year	2013

Project Description *Navy Base ICTF*

Inputs

Weaving configuration	One-Sided
Weaving number of lanes, N	3
Weaving segment length, L_S	1090ft
Freeway free-flow speed, FFS	60 mph
Segment type	Freeway
Freeway minimum speed, S_{MIN}	15
Freeway maximum capacity, C_{IFL}	2300
Terrain type	Level

Conversions to pc/h Under Base Conditions

	V (veh/h)	PHF	Truck (%)	RV (%)	E_T	E_R	f_{HV}	fp	v (pc/h)
V_{FF}	2594	0.90	16	0	1.5	1.2	0.926	1.00	3113
V_{RF}	1070	0.90	5	0	1.5	1.2	0.976	1.00	1219
V_{FR}	448	0.90	14	0	1.5	1.2	0.935	1.00	533
V_{RR}	185	0.90	5	0	1.5	1.2	0.976	1.00	211
V_{NW}	3324							V =	5076
V_W	1752								
VR	0.345								

Configuration Characteristics

Minimum maneuver lanes, N_{WL}	2 lc	Minimum weaving lane changes, LC_{MIN}	1752 lc/h
Interchange density, ID	0.7 int/mi	Weaving lane changes, LC_W	1903 lc/h
Minimum RF lane changes, LC_{RF}	1 lc/pc	Non-weaving lane changes, LC_{NW}	698 lc/h
Minimum FR lane changes, LC_{FR}	1 lc/pc	Total lane changes, LC_{ALL}	2601 lc/h
Minimum RR lane changes, LC_{RR}	lc/pc	Non-weaving vehicle index, I_{NW}	254

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment flow rate, v	5076 pc/h	Weaving intensity factor, W	0.449
Weaving segment capacity, c_w	5331 veh/h	Weaving segment speed, S	41.4 mph
Weaving segment v/c ratio	0.882	Average weaving speed, S_W	46.1 mph
Weaving segment density, D	40.9 pc/mi/ln	Average non-weaving speed, S_{NW}	39.3 mph
Level of Service, LOS	E	Maximum weaving length, L_{MAX}	6073 ft

Notes

a. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments".
b. For volumes that exceed the weaving segment capacity, the level of service is "F".

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Navy Base ICTF

FREEWAY WEAVING WORKSHEET

General Information

Analyst	AJR
Agency/Company	Atkins
Date Performed	3/20/2014
Analysis Time Period	PM Peak

Site Information

Freeway/Dir of Travel	I-526 EB
Weaving Segment Location	3170 - Rhett to Virginia
Analysis Year	2013

Project Description *Navy Base ICTF*

Inputs

Weaving configuration	One-Sided
Weaving number of lanes, N	3
Weaving segment length, L_S	1090ft
Freeway free-flow speed, FFS	60 mph
Segment type	Freeway
Freeway minimum speed, S_{MIN}	15
Freeway maximum capacity, C_{IFL}	2300
Terrain type	Level

Conversions to pc/h Under Base Conditions

	V (veh/h)	PHF	Truck (%)	RV (%)	E_T	E_R	f_{HV}	fp	v (pc/h)
V_{FF}	2486	0.90	5	0	1.5	1.2	0.976	1.00	2831
V_{RF}	900	0.90	5	0	1.5	1.2	0.976	1.00	1025
V_{FR}	125	0.90	46	0	1.5	1.2	0.813	1.00	171
V_{RR}	45	0.90	53	0	1.5	1.2	0.791	1.00	63
V_{NW}	2894							V =	4090
V_W	1196								
VR	0.292								

Configuration Characteristics

Minimum maneuver lanes, N_{WL}	2 lc	Minimum weaving lane changes, LC_{MIN}	1196 lc/h
Interchange density, ID	0.7 int/mi	Weaving lane changes, LC_W	1347 lc/h
Minimum RF lane changes, LC_{RF}	1 lc/pc	Non-weaving lane changes, LC_{NW}	609 lc/h
Minimum FR lane changes, LC_{FR}	1 lc/pc	Total lane changes, LC_{ALL}	1956 lc/h
Minimum RR lane changes, LC_{RR}	lc/pc	Non-weaving vehicle index, I_{NW}	221

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment flow rate, v	4090 pc/h	Weaving intensity factor, W	0.358
Weaving segment capacity, c_w	5742 veh/h	Weaving segment speed, S	45.8 mph
Weaving segment v/c ratio	0.695	Average weaving speed, S_W	48.1 mph
Weaving segment density, D	29.8 pc/mi/ln	Average non-weaving speed, S_{NW}	44.8 mph
Level of Service, LOS	D	Maximum weaving length, L_{MAX}	5503 ft

Notes

a. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments".
b. For volumes that exceed the weaving segment capacity, the level of service is "F".

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-526 EB*
Agency or Company	*Atkins*	From/To	*3180-Virginia to ClementsFerry*
Date Performed	*4/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2013*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*3664*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*13*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length	*mi*
			Up/Down %	

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.939*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*60.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*60.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*2168*	pc/h/ln
S	*54.1*	mph
D = v_p / S	*40.0*	pc/mi/ln
LOS	*E*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-526 EB*
Agency or Company	*Atkins*	From/To	*3180-Virginia to ClementsFerry*
Date Performed	*4/25/2014*	Jurisdiction	
Analysis Time Period	*PM Peak*	Analysis Year	*2013*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*3386*	veh/h	Peak-Hour Factor, PHF	*0.90*	
AADT		veh/day	%Trucks and Buses, P_T	*5*	
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*	
Peak-Hr Direction Prop, D			General Terrain:	*Level*	
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*	

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.976*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*60.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*60.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1928*	pc/h/ln
S	*58.0*	mph
D = v_p / S	*33.2*	pc/mi/ln
LOS	*D*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-526 EB
Agency or Company	Atkins	Junction	3190-EB Off to ClementsFerrySB
Date Performed	3/20/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2013

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Freeway Number of Lanes, N	2	Downstream Adj Ramp	
☐ Yes	☐ On	Ramp Number of Lanes, N	1	☐ Yes	☐ On
☑ No	☐ Off	Acceleration Lane Length, L_A		☑ No	☐ Off
L_{up} =	ft	Deceleration Lane Length L_D	250	L_{down} =	ft
V_u =	veh/h	Freeway Volume, V_F	3664	V_D =	veh/h
		Ramp Volume, V_R	320		
		Freeway Free-Flow Speed, S_{FF}	60.0		
		Ramp Free-Flow Speed, S_{FR}	45.0		

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	3664	0.90	Level	13	0	0.939	1.00	4336
Ramp	320	0.90	Level	12	0	0.943	1.00	377
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 1.000 using Equation (Exhibit 13-7)

V_{12} = 4336 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	4336	Exhibit 13-8	4600	No
$V_{FO} = V_F - V_R$	3959	Exhibit 13-8	4600	No
V_R	377	Exhibit 13-10	2100	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	4336	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = 39.3 (pc/mi/ln)

LOS = E (Exhibit 13-2)

Speed Determination

D_s = 0.332 (Exhibit 13-12)

S_R= 54.0 mph (Exhibit 13-12)

S_0= N/A mph (Exhibit 13-12)

S = 54.0 mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-526 EB
Agency or Company	Atkins	Junction	3190-EB Off to ClementsFerrySB
Date Performed	3/20/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2013

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Number of Lanes, N	2	Downstream Adj Ramp	
☐ Yes	☐ On	Acceleration Lane Length, L_A		☐ Yes	☐ On
☑ No	☐ Off	Deceleration Lane Length L_D	250	☑ No	☐ Off
L_{up} =	ft	Freeway Volume, V_F	3386	L_{down} =	ft
V_u =	veh/h	Ramp Volume, V_R	166	V_D =	veh/h
		Freeway Free-Flow Speed, S_{FF}	60.0		
		Ramp Free-Flow Speed, S_{FR}	45.0		

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	3386	0.90	Level	5	0	0.976	1.00	3856
Ramp	166	0.90	Level	5	0	0.976	1.00	189
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 1.000 using Equation (Exhibit 13-7)

V_{12} = 3856 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	3856	Exhibit 13-8	4600	No
$V_{FO} = V_F - V_R$	3667	Exhibit 13-8	4600	No
V_R	189	Exhibit 13-10	2100	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	3856	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = 35.2 (pc/mi/ln)

LOS = E (Exhibit 13-2)

Speed Determination

D_s = 0.315 (Exhibit 13-12)

S_R= 54.3 mph (Exhibit 13-12)

S_0= N/A mph (Exhibit 13-12)

S = 54.3 mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-526 EB
Agency or Company	Atkins	Junction	3200-EB Off to ClementsFerryNB
Date Performed	3/20/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2013

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Freeway Number of Lanes, N	2	Downstream Adj Ramp	
☐ Yes	☐ On	Ramp Number of Lanes, N	1	☐ Yes	☐ On
☑ No	☐ Off	Acceleration Lane Length, L_A		☑ No	☐ Off
L_{up} =	ft	Deceleration Lane Length L_D	900	L_{down} =	ft
V_u =	veh/h	Freeway Volume, V_F	3344	V_D =	veh/h
		Ramp Volume, V_R	827		
		Freeway Free-Flow Speed, S_{FF}	60.0		
		Ramp Free-Flow Speed, S_{FR}	25.0		

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	3344	0.90	Level	13	0	0.939	1.00	3957
Ramp	827	0.90	Level	20	0	0.909	1.00	1011
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 1.000 using Equation (Exhibit 13-7)

V_{12} = 3957 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	3957	Exhibit 13-8	4600	No
$V_{FO} = V_F - V_R$	2946	Exhibit 13-8	4600	No
V_R	1011	Exhibit 13-10	1900	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	3957	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = 30.2 (pc/mi/ln)

LOS = D (Exhibit 13-2)

Speed Determination

D_s = 0.649 (Exhibit 13-12)

S_R= 48.3 mph (Exhibit 13-12)

S_0= N/A mph (Exhibit 13-12)

S = 48.3 mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-526 EB
Agency or Company	Atkins	Junction	3200-EB Off to ClementsFerryNB
Date Performed	3/20/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2013

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Number of Lanes, N	2	Downstream Adj Ramp	
☐ Yes	☐ On	Acceleration Lane Length, L_A		☐ Yes	☐ On
☑ No	☐ Off	Deceleration Lane Length L_D	900	☑ No	☐ Off
L_{up} =	ft	Freeway Volume, V_F	3220	L_{down} =	ft
V_u =	veh/h	Ramp Volume, V_R	759	V_D =	veh/h
		Freeway Free-Flow Speed, S_{FF}	60.0		
		Ramp Free-Flow Speed, S_{FR}	25.0		

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	3220	0.90	Level	5	0	0.976	1.00	3667
Ramp	759	0.90	Level	13	0	0.939	1.00	898
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 1.000 using Equation (Exhibit 13-7)

V_{12} = 3667 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	3667	Exhibit 13-8	4600	No
$V_{FO} = V_F - V_R$	2769	Exhibit 13-8	4600	No
V_R	898	Exhibit 13-10	1900	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	3667	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = 27.7 (pc/mi/ln)

LOS = C (Exhibit 13-2)

Speed Determination

D_s = 0.639 (Exhibit 13-12)

S_R= 48.5 mph (Exhibit 13-12)

S_0= N/A mph (Exhibit 13-12)

S = 48.5 mph (Exhibit 13-13)

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-526 EB*
Agency or Company	*Atkins*	From/To	*3205-ClemFerry NB Off to NB On*
Date Performed	*4/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2013*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*2517*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*11*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length	*mi*
			Up/Down %	

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.948*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*60.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*60.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1475*	pc/h/ln
S	*60.0*	mph
D = v_p / S	*24.6*	pc/mi/ln
LOS	*C*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-526 EB*
Agency or Company	*Atkins*	From/To	*3205-ClemFerry NB Off to NB On*
Date Performed	*4/25/2014*	Jurisdiction	
Analysis Time Period	*PM Peak*	Analysis Year	*2013*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*2461*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*2*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length	*mi*
			Up/Down %	

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.990*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*60.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*60.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1381*	pc/h/ln
S	*60.0*	mph
D = v_p / S	*23.0*	pc/mi/ln
LOS	*C*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-526 EB
Agency or Company	Atkins	Junction	3210-EB On from Clements Ferry
Date Performed	4/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2013

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Freeway Number of Lanes, N: 2	☐ Yes ☐ On
☑ No ☐ Off	Ramp Number of Lanes, N: 1	☑ No ☐ Off
L_{up} = ft	Acceleration Lane Length, L_A: 1025	L_{down} = ft
V_u = veh/h	Deceleration Lane Length L_D:	V_D = veh/h
	Freeway Volume, V_F: 2517	
	Ramp Volume, V_R: 366	
	Freeway Free-Flow Speed, S_{FF}: 60.0	
	Ramp Free-Flow Speed, S_{FR}: 45.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	2517	0.90	Level	11	0	0.948	1.00	2950
Ramp	366	0.90	Level	14	0	0.935	1.00	435
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 1.000 using Equation (Exhibit 13-6)

V_{12} = 2950 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	3385	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	3385	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = 25.3 (pc/mi/ln)

LOS = C (Exhibit 13-2)

Speed Determination

M_S = 0.344 (Exibit 13-11)

S_R= 53.8 mph (Exhibit 13-11)

S_0= N/A mph (Exhibit 13-11)

S = 53.8 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-526 EB
Agency or Company	Atkins	Junction	3210-EB On from Clements Ferry
Date Performed	4/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2013

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Freeway Number of Lanes, N: 2	☐ Yes ☐ On
☑ No ☐ Off	Ramp Number of Lanes, N: 1	☑ No ☐ Off
L_{up} = ft	Acceleration Lane Length, L_A: 1025	L_{down} = ft
V_u = veh/h	Deceleration Lane Length L_D:	V_D = veh/h
	Freeway Volume, V_F: 2461	
	Ramp Volume, V_R: 561	
	Freeway Free-Flow Speed, S_{FF}: 60.0	
	Ramp Free-Flow Speed, S_{FR}: 45.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	2461	0.90	Level	2	0	0.990	1.00	2762
Ramp	561	0.90	Level	3	0	0.985	1.00	633
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 1.000 using Equation (Exhibit 13-6)

V_{12} = 2762 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	3395	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	3395	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = 25.2 (pc/mi/ln)

LOS = C (Exhibit 13-2)

Speed Determination

M_S = 0.345 (Exibit 13-11)

S_R= 53.8 mph (Exhibit 13-11)

S_0= N/A mph (Exhibit 13-11)

S = 53.8 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-526 EB*
Agency or Company	*Atkins*	From/To	*3220-ClementsFerrytoRiversLand*
Date Performed	*4/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2013*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*2883*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*11*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length	*mi*
			Up/Down %	

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.948*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*60.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*60.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1690*	pc/h/ln
S	*59.9*	mph
D = v_p / S	*28.2*	pc/mi/ln
LOS	*D*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-526 EB*
Agency or Company	*Atkins*	From/To	*3220-ClementsFerrytoRiversLand*
Date Performed	*4/25/2014*	Jurisdiction	
Analysis Time Period	*PM Peak*	Analysis Year	*2013*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*3022*	veh/h	Peak-Hour Factor, PHF	*0.90*	
AADT		veh/day	%Trucks and Buses, P_T	*3*	
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*	
Peak-Hr Direction Prop, D			General Terrain:	*Level*	
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*	

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.985*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*60.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*60.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1704*	pc/h/ln
S	*59.8*	mph
D = v_p / S	*28.5*	pc/mi/ln
LOS	*D*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-526 EB
Agency or Company	Atkins	Junction	3230-EB Off to River Landing
Date Performed	3/20/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2013

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Freeway Number of Lanes, N	2	Downstream Adj Ramp	
☐ Yes	☐ On	Ramp Number of Lanes, N	1	☐ Yes	☐ On
☑ No	☐ Off	Acceleration Lane Length, L_A		☑ No	☐ Off
L_{up} =	ft	Deceleration Lane Length L_D	800	L_{down} =	ft
V_u =	veh/h	Freeway Volume, V_F	2883	V_D =	veh/h
		Ramp Volume, V_R	740		
		Freeway Free-Flow Speed, S_{FF}	65.0		
		Ramp Free-Flow Speed, S_{FR}	45.0		

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	2883	0.90	Level	11	0	0.948	1.00	3380
Ramp	740	0.90	Level	3	0	0.985	1.00	835
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 1.000 using Equation (Exhibit 13-7)

V_{12} = 3380 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	3380	Exhibit 13-8	4700	No
$V_{FO} = V_F - V_R$	2545	Exhibit 13-8	4700	No
V_R	835	Exhibit 13-10	2100	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	3380	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = 26.1 (pc/mi/ln)

LOS = C (Exhibit 13-2)

Speed Determination

D_s = 0.373 (Exhibit 13-12)

S_R= 56.4 mph (Exhibit 13-12)

S_0= N/A mph (Exhibit 13-12)

S = 56.4 mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-526 EB
Agency or Company	Atkins	Junction	3230-EB Off to River Landing
Date Performed	3/20/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2013

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Number of Lanes, N	2	Downstream Adj Ramp	
☐ Yes	☐ On	Acceleration Lane Length, L_A		☐ Yes	☐ On
☑ No	☐ Off	Deceleration Lane Length L_D	800	☑ No	☐ Off
L_{up} =	ft	Freeway Volume, V_F	3022	L_{down} =	ft
V_u =	veh/h	Ramp Volume, V_R	766	V_D =	veh/h
		Freeway Free-Flow Speed, S_{FF}	65.0		
		Ramp Free-Flow Speed, S_{FR}	45.0		

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	3022	0.90	Level	3	0	0.985	1.00	3408
Ramp	766	0.90	Level	2	0	0.990	1.00	860
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 1.000 using Equation (Exhibit 13-7)

V_{12} = 3408 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	3408	Exhibit 13-8	4700	No
$V_{FO} = V_F - V_R$	2548	Exhibit 13-8	4700	No
V_R	860	Exhibit 13-10	2100	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	3408	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = 26.4 (pc/mi/ln)

LOS = C (Exhibit 13-2)

Speed Determination

D_s = 0.375 (Exhibit 13-12)

S_R= 56.4 mph (Exhibit 13-12)

S_0= N/A mph (Exhibit 13-12)

S = 56.4 mph (Exhibit 13-13)

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-526 EB*
Agency or Company	*Atkins*	From/To	*3235-RiverLa Off to RiverLa On*
Date Performed	*4/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2013*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*2143*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*14*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length	*mi*
			Up/Down %	

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.935*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*65.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*65.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1274*	pc/h/ln
S	*65.0*	mph
D = v_p / S	*19.6*	pc/mi/ln
LOS	*C*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-526 EB*
Agency or Company	*Atkins*	From/To	*3235-RiverLa Off to RiverLa On*
Date Performed	*4/25/2014*	Jurisdiction	
Analysis Time Period	*PM Peak*	Analysis Year	*2013*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*2256*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*3*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.985*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*65.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*65.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1272*	pc/h/ln
S	*65.0*	mph
D = v_p / S	*19.6*	pc/mi/ln
LOS	*C*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-526 EB
Agency or Company	Atkins	Junction	3240-EB On from River Landing
Date Performed	4/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2013

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Freeway Number of Lanes, N: 2	☐ Yes ☐ On
☑ No ☐ Off	Ramp Number of Lanes, N: 1	☑ No ☐ Off
L_{up} = ft	Acceleration Lane Length, L_A: 1400	L_{down} = ft
V_u = veh/h	Deceleration Lane Length L_D:	V_D = veh/h
	Freeway Volume, V_F: 2143	
	Ramp Volume, V_R: 572	
	Freeway Free-Flow Speed, S_{FF}: 65.0	
	Ramp Free-Flow Speed, S_{FR}: 25.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	2143	0.90	Level	14	0	0.935	1.00	2548
Ramp	572	0.90	Level	9	0	0.957	1.00	664
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 1.000 using Equation (Exhibit 13-6)

V_{12} = 2548 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	3212	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	3212	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = 21.4 (pc/mi/ln)

LOS = C (Exhibit 13-2)

Speed Determination

M_S = 0.348 (Exibit 13-11)

S_R= 57.0 mph (Exhibit 13-11)

S_0= N/A mph (Exhibit 13-11)

S = 57.0 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-526 EB
Agency or Company	Atkins	Junction	3240-EB On from River Landing
Date Performed	4/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2013

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Freeway Number of Lanes, N: 2	☐ Yes ☐ On
☑ No ☐ Off	Ramp Number of Lanes, N: 1	☑ No ☐ Off
L_{up} = ft	Acceleration Lane Length, L_A: 1400	L_{down} = ft
V_u = veh/h	Deceleration Lane Length L_D:	V_D = veh/h
	Freeway Volume, V_F: 2256	
	Ramp Volume, V_R: 471	
	Freeway Free-Flow Speed, S_{FF}: 65.0	
	Ramp Free-Flow Speed, S_{FR}: 25.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	2256	0.90	Level	3	0	0.985	1.00	2544
Ramp	471	0.90	Level	10	0	0.952	1.00	550
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 1.000 using Equation (Exhibit 13-6)

V_{12} = 2544 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	3094	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	3094	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = 20.6 (pc/mi/ln)

LOS = C (Exhibit 13-2)

Speed Determination

M_S = 0.337 (Exibit 13-11)

S_R= 57.2 mph (Exhibit 13-11)

S_0= N/A mph (Exhibit 13-11)

S = 57.2 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-526 EB*
Agency or Company	*Atkins*	From/To	*3250-RiverLanding to LongPoint*
Date Performed	*4/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2013*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*2715*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*13*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length	*mi*
			Up/Down %	

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.939*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*65.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*65.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1606*	pc/h/ln
S	*64.4*	mph
D = v_p / S	*24.9*	pc/mi/ln
LOS	*C*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-526 EB*
Agency or Company	*Atkins*	From/To	*3250-RiverLanding to LongPoint*
Date Performed	*4/25/2014*	Jurisdiction	
Analysis Time Period	*PM Peak*	Analysis Year	*2013*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*2727*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*4*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.980*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*65.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*65.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1545*	pc/h/ln
S	*64.7*	mph
D = v_p / S	*23.9*	pc/mi/ln
LOS	*C*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-526 EB
Agency or Company	Atkins	Junction	3260-EB Off to Long Point
Date Performed	3/20/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2013

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Freeway Number of Lanes, N	2	Downstream Adj Ramp	
☐ Yes	☐ On	Ramp Number of Lanes, N	1	☐ Yes	☐ On
☑ No	☐ Off	Acceleration Lane Length, L_A		☑ No	☐ Off
L_{up} =	ft	Deceleration Lane Length L_D	225	L_{down} =	ft
V_u =	veh/h	Freeway Volume, V_F	2715	V_D =	veh/h
		Ramp Volume, V_R	1047		
		Freeway Free-Flow Speed, S_{FF}	65.0		
		Ramp Free-Flow Speed, S_{FR}	45.0		

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	2715	0.90	Level	13	0	0.939	1.00	3213
Ramp	1047	0.90	Level	21	0	0.905	1.00	1285
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 1.000 using Equation (Exhibit 13-7)

V_{12} = 3213 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	3213	Exhibit 13-8	4700	No
$V_{FO} = V_F - V_R$	1928	Exhibit 13-8	4700	No
V_R	1285	Exhibit 13-10	2100	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	3213	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = 29.9 (pc/mi/ln)

LOS = D (Exhibit 13-2)

Speed Determination

D_s = 0.414 (Exhibit 13-12)

S_R= 55.5 mph (Exhibit 13-12)

S_0= N/A mph (Exhibit 13-12)

S = 55.5 mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-526 EB
Agency or Company	Atkins	Junction	3260-EB Off to Long Point
Date Performed	3/20/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2013

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Freeway Number of Lanes, N	2	Downstream Adj Ramp	
☐ Yes	☐ On	Ramp Number of Lanes, N	1	☐ Yes	☐ On
☑ No	☐ Off	Acceleration Lane Length, L_A		☑ No	☐ Off
L_{up} =	ft	Deceleration Lane Length L_D	225	L_{down} =	ft
V_u =	veh/h	Freeway Volume, V_F	2727	V_D =	veh/h
		Ramp Volume, V_R	1122		
		Freeway Free-Flow Speed, S_{FF}	65.0		
		Ramp Free-Flow Speed, S_{FR}	45.0		

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	2727	0.90	Level	4	0	0.980	1.00	3091
Ramp	1122	0.90	Level	5	0	0.976	1.00	1278
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 1.000 using Equation (Exhibit 13-7)

V_{12} = 3091 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	3091	Exhibit 13-8	4700	No
$V_{FO} = V_F - V_R$	1813	Exhibit 13-8	4700	No
V_R	1278	Exhibit 13-10	2100	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	3091	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = 28.8 (pc/mi/ln)

LOS = D (Exhibit 13-2)

Speed Determination

D_s = 0.413 (Exhibit 13-12)

S_R= 55.5 mph (Exhibit 13-12)

S_0= N/A mph (Exhibit 13-12)

S = 55.5 mph (Exhibit 13-13)

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-526 EB*
Agency or Company	*Atkins*	From/To	*3265-LongPt Off to LongPtWB On*
Date Performed	*4/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2013*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*1668*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*7*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length	*mi*
			Up/Down %	

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.966*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*65.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*65.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*959*	pc/h/ln
S	*65.0*	mph
D = v_p / S	*14.8*	pc/mi/ln
LOS	*B*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-526 EB*
Agency or Company	*Atkins*	From/To	*3265-LongPt Off to LongPtWB On*
Date Performed	*4/25/2014*	Jurisdiction	
Analysis Time Period	*PM Peak*	Analysis Year	*2013*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*1605*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*3*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.985*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*65.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*65.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*905*	pc/h/ln
S	*65.0*	mph
D = v_p / S	*13.9*	pc/mi/ln
LOS	*B*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-526 EB
Agency or Company	Atkins	Junction	3270-EB On from Long Point WB
Date Performed	4/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2013

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Freeway Number of Lanes, N: 2	☐ Yes ☐ On
☑ No ☐ Off	Ramp Number of Lanes, N: 1	☑ No ☐ Off
L_{up} = ft	Acceleration Lane Length, L_A: 925	L_{down} = ft
V_u = veh/h	Deceleration Lane Length L_D:	V_D = veh/h
	Freeway Volume, V_F: 1668	
	Ramp Volume, V_R: 454	
	Freeway Free-Flow Speed, S_{FF}: 65.0	
	Ramp Free-Flow Speed, S_{FR}: 25.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	1668	0.90	Level	7	0	0.966	1.00	1918
Ramp	454	0.90	Level	7	0	0.966	1.00	522
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 1.000 using Equation (Exhibit 13-6)

V_{12} = 1918 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	2440	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	2440	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = 18.5 (pc/mi/ln)

LOS = B (Exhibit 13-2)

Speed Determination

M_S = 0.319 (Exibit 13-11)

S_R= 57.7 mph (Exhibit 13-11)

S_0= N/A mph (Exhibit 13-11)

S = 57.7 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-526 EB
Agency or Company	Atkins	Junction	3270-EB On from Long Point WB
Date Performed	4/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2013

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Number of Lanes, N: 2	☐ Yes ☐ On
☑ No ☐ Off	Acceleration Lane Length, L_A: 925	☑ No ☐ Off
L_{up} = ft	Deceleration Lane Length L_D:	L_{down} = ft
V_u = veh/h	Freeway Volume, V_F: 1605	V_D = veh/h
	Ramp Volume, V_R: 454	
	Freeway Free-Flow Speed, S_{FF}: 65.0	
	Ramp Free-Flow Speed, S_{FR}: 25.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	1605	0.90	Level	3	0	0.985	1.00	1810
Ramp	454	0.90	Level	10	0	0.952	1.00	530
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 1.000 using Equation (Exhibit 13-6)

V_{12} = 1810 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	2340	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	2340	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = 17.7 (pc/mi/ln)

LOS = B (Exhibit 13-2)

Speed Determination

M_S = 0.315 (Exibit 13-11)

S_R= 57.7 mph (Exhibit 13-11)

S_0= N/A mph (Exhibit 13-11)

S = 57.7 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-526 EB
Agency or Company	Atkins	Junction	3280-EB On from Long Point EB
Date Performed	4/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2013

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Freeway Number of Lanes, N: 2	☐ Yes ☐ On
☑ No ☐ Off	Ramp Number of Lanes, N: 1	☑ No ☐ Off
L_{up} = ft	Acceleration Lane Length, L_A: 625	L_{down} = ft
V_u = veh/h	Deceleration Lane Length L_D:	V_D = veh/h
	Freeway Volume, V_F: 2122	
	Ramp Volume, V_R: 292	
	Freeway Free-Flow Speed, S_{FF}: 65.0	
	Ramp Free-Flow Speed, S_{FR}: 45.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	2122	0.90	Level	7	0	0.966	1.00	2440
Ramp	292	0.90	Level	16	0	0.926	1.00	350
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 1.000 using Equation (Exhibit 13-6)

V_{12} = 2440 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	2790	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	2790	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = 23.2 (pc/mi/ln)

LOS = C (Exhibit 13-2)

Speed Determination

M_S = 0.328 (Exibit 13-11)

S_R= 57.5 mph (Exhibit 13-11)

S_0= N/A mph (Exhibit 13-11)

S = 57.5 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-526 EB
Agency or Company	Atkins	Junction	3280-EB On from Long Point EB
Date Performed	4/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2013

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Number of Lanes, N: 2	☐ Yes ☐ On
☑ No ☐ Off	Acceleration Lane Length, L_A: 625	☑ No ☐ Off
L_{up} = ft	Deceleration Lane Length L_D:	L_{down} = ft
V_u = veh/h	Freeway Volume, V_F: 2059	V_D = veh/h
	Ramp Volume, V_R: 565	
	Freeway Free-Flow Speed, S_{FF}: 65.0	
	Ramp Free-Flow Speed, S_{FR}: 45.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	2059	0.90	Level	5	0	0.976	1.00	2345
Ramp	565	0.90	Level	8	0	0.962	1.00	653
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 1.000 using Equation (Exhibit 13-6)

V_{12} = 2345 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	2998	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	2998	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = 24.6 (pc/mi/ln)

LOS = C (Exhibit 13-2)

Speed Determination

M_S = 0.343 (Exibit 13-11)

S_R= 57.1 mph (Exhibit 13-11)

S_0= N/A mph (Exhibit 13-11)

S = 57.1 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-526 EB*
Agency or Company	*Atkins*	From/To	*3290-LongPt.toUS17/Hungryneck*
Date Performed	*4/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2013*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*2414*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*8*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length	*mi*
			Up/Down %	

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.962*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*65.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*65.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1395*	pc/h/ln
S	*65.0*	mph
D = v_p / S	*21.5*	pc/mi/ln
LOS	*C*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-526 EB*
Agency or Company	*Atkins*	From/To	*3290-LongPt.toUS17/Hungryneck*
Date Performed	*4/25/2014*	Jurisdiction	
Analysis Time Period	*PM Peak*	Analysis Year	*2013*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*2624*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*6*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.971*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*65.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*65.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1502*	pc/h/ln
S	*64.9*	mph
D = v_p / S	*23.2*	pc/mi/ln
LOS	*C*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-526 EB
Agency or Company	Atkins	Junction	3300-EB Off to US17/Hungryneck
Date Performed	3/20/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2013

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Freeway Number of Lanes, N	2	Downstream Adj Ramp	
☐ Yes	☐ On	Ramp Number of Lanes, N	1	☐ Yes	☐ On
☑ No	☐ Off	Acceleration Lane Length, L_A		☑ No	☐ Off
L_{up} =	ft	Deceleration Lane Length L_D	225	L_{down} =	ft
V_u =	veh/h	Freeway Volume, V_F	2414	V_D =	veh/h
		Ramp Volume, V_R	1091		
		Freeway Free-Flow Speed, S_{FF}	55.0		
		Ramp Free-Flow Speed, S_{FR}	45.0		

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	2414	0.90	Level	8	0	0.962	1.00	2790
Ramp	1091	0.90	Level	4	0	0.980	1.00	1236
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 1.000 using Equation (Exhibit 13-7)

V_{12} = 2790 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	2790	Exhibit 13-8	4500	No
$V_{FO} = V_F - V_R$	1554	Exhibit 13-8	4500	No
V_R	1236	Exhibit 13-10	2100	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	2790	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = 26.2 (pc/mi/ln)

LOS = C (Exhibit 13-2)

Speed Determination

D_s = 0.409 (Exhibit 13-12)

S_R= 49.7 mph (Exhibit 13-12)

S_0= N/A mph (Exhibit 13-12)

S = 49.7 mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-526 EB
Agency or Company	Atkins	Junction	3300-EB Off to US17/Hungryneck
Date Performed	3/20/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2013

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Number of Lanes, N	2	Downstream Adj Ramp	
☐ Yes	☐ On	Acceleration Lane Length, L_A		☐ Yes	☐ On
☑ No	☐ Off	Deceleration Lane Length L_D	225	☑ No	☐ Off
L_{up} =	ft	Freeway Volume, V_F	2624	L_{down} =	ft
V_u =	veh/h	Ramp Volume, V_R	934	V_D =	veh/h
		Freeway Free-Flow Speed, S_{FF}	55.0		
		Ramp Free-Flow Speed, S_{FR}	45.0		

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	2624	0.90	Level	6	0	0.971	1.00	3003
Ramp	934	0.90	Level	4	0	0.980	1.00	1059
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 1.000 using Equation (Exhibit 13-7)

V_{12} = 3003 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	3003	Exhibit 13-8	4500	No
$V_{FO} = V_F - V_R$	1944	Exhibit 13-8	4500	No
V_R	1059	Exhibit 13-10	2100	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	3003	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = 28.1 (pc/mi/ln)

LOS = D (Exhibit 13-2)

Speed Determination

D_s = 0.393 (Exhibit 13-12)

S_R= 49.9 mph (Exhibit 13-12)

S_0= N/A mph (Exhibit 13-12)

S = 49.9 mph (Exhibit 13-13)

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-526 EB*
Agency or Company	*Atkins*	From/To	*3310-US17/Hungryneck to US17*
Date Performed	*4/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2013*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*1323*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*12*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length	*mi*
			Up/Down %	

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.943*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*55.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*55.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*779*	pc/h/ln
S	*55.0*	mph
D = v_p / S	*14.2*	pc/mi/ln
LOS	*B*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-526 EB*
Agency or Company	*Atkins*	From/To	*3310-US17/Hungryneck to US17*
Date Performed	*4/25/2014*	Jurisdiction	
Analysis Time Period	*PM Peak*	Analysis Year	*2013*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*1690*	veh/h	Peak-Hour Factor, PHF	*0.90*	
AADT		veh/day	%Trucks and Buses, P_T	*7*	
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*	
Peak-Hr Direction Prop, D			General Terrain:	*Level*	
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*	

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.966*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*55.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*55.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*972*	pc/h/ln
S	*55.0*	mph
D = v_p / S	*17.7*	pc/mi/ln
LOS	*B*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-526 EB
Agency or Company	Atkins	Junction	3320-EB Off to US17 SB
Date Performed	3/20/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2013

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Freeway Number of Lanes, N	2	Downstream Adj Ramp	
☐ Yes	☐ On	Ramp Number of Lanes, N	1	☐ Yes	☐ On
☑ No	☐ Off	Acceleration Lane Length, L_A		☑ No	☐ Off
L_{up} =	ft	Deceleration Lane Length L_D	250	L_{down} =	ft
V_u =	veh/h	Freeway Volume, V_F	1323	V_D =	veh/h
		Ramp Volume, V_R	999		
		Freeway Free-Flow Speed, S_{FF}	55.0		
		Ramp Free-Flow Speed, S_{FR}	45.0		

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	1323	0.90	Level	12	0	0.943	1.00	1558
Ramp	999	0.90	Level	12	0	0.943	1.00	1177
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 1.000 using Equation (Exhibit 13-7)

V_{12} = 1558 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	1558	Exhibit 13-8	4500	No
$V_{FO} = V_F - V_R$	381	Exhibit 13-8	4500	No
V_R	1177	Exhibit 13-10	2100	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	1558	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = 15.4 (pc/mi/ln)

LOS = B (Exhibit 13-2)

Speed Determination

D_s = 0.404 (Exhibit 13-12)

S_R= 49.7 mph (Exhibit 13-12)

S_0= N/A mph (Exhibit 13-12)

S = 49.7 mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-526 EB
Agency or Company	Atkins	Junction	3320-EB Off to US17 SB
Date Performed	3/20/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2013

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp
☐ Yes ☐ On
☑ No ☐ Off
L_{up} = ft
V_u = veh/h

Freeway Number of Lanes, N	2
Ramp Number of Lanes, N	1
Acceleration Lane Length, L_A	
Deceleration Lane Length L_D	250
Freeway Volume, V_F	1690
Ramp Volume, V_R	979
Freeway Free-Flow Speed, S_{FF}	55.0
Ramp Free-Flow Speed, S_{FR}	45.0

Downstream Adj Ramp
☐ Yes ☐ On
☑ No ☐ Off
L_{down} = ft
V_D = veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	1690	0.90	Level	7	0	0.966	1.00	1943
Ramp	979	0.90	Level	10	0	0.952	1.00	1142
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)
P_{FM} = using Equation (Exhibit 13-6)
V_{12} = pc/h
V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)
Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No
Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No
If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = (pc/mi/ln)
LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)
S_R= mph (Exhibit 13-11)
S_0= mph (Exhibit 13-11)
S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)
P_{FD} = 1.000 using Equation (Exhibit 13-7)
V_{12} = 1943 pc/h
V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)
Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No
Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No
If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	1943	Exhibit 13-8	4500	No
$V_{FO} = V_F - V_R$	801	Exhibit 13-8	4500	No
V_R	1142	Exhibit 13-10	2100	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	1943	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = 18.7 (pc/mi/ln)
LOS = B (Exhibit 13-2)

Speed Determination

D_s = 0.401 (Exhibit 13-12)
S_R= 49.8 mph (Exhibit 13-12)
S_0= N/A mph (Exhibit 13-12)
S = 49.8 mph (Exhibit 13-13)

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-526 EB*
Agency or Company	*Atkins*	From/To	*3325-US17 SB Off to US17 SB On*
Date Performed	*4/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2013*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*324*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*13*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length	*mi*
			Up/Down %	

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.939*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*55.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*55.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*192*	pc/h/ln
S	*55.0*	mph
D = v_p / S	*3.5*	pc/mi/ln
LOS	*A*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-526 EB*
Agency or Company	*Atkins*	From/To	*3325-US17 SB Off to US17 SB On*
Date Performed	*4/25/2014*	Jurisdiction	
Analysis Time Period	*PM Peak*	Analysis Year	*2013*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*711*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*2*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length	*mi*
			Up/Down %	

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.990*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*55.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*55.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*399*	pc/h/ln
S	*55.0*	mph
D = v_p / S	*7.3*	pc/mi/ln
LOS	*A*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-526 EB
Agency or Company	Atkins	Junction	3330-EB On from US17 SB
Date Performed	4/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2013

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Freeway Number of Lanes, N: 2	☐ Yes ☐ On
☑ No ☐ Off	Ramp Number of Lanes, N: 1	☑ No ☐ Off
L_{up} = ft	Acceleration Lane Length, L_A: 725	L_{down} = ft
V_u = veh/h	Deceleration Lane Length L_D:	V_D = veh/h
	Freeway Volume, V_F: 324	
	Ramp Volume, V_R: 350	
	Freeway Free-Flow Speed, S_{FF}: 55.0	
	Ramp Free-Flow Speed, S_{FR}: 25.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	324	0.90	Level	13	0	0.939	1.00	383
Ramp	350	0.90	Level	5	0	0.976	1.00	399
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 1.000 using Equation (Exhibit 13-6)

V_{12} = 383 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	782	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	782	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = 6.8 (pc/mi/ln)

LOS = A (Exhibit 13-2)

Speed Determination

M_S = 0.293 (Exibit 13-11)

S_R= 51.2 mph (Exhibit 13-11)

S_0= N/A mph (Exhibit 13-11)

S = 51.2 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-526 EB
Agency or Company	Atkins	Junction	3330-EB On from US17 SB
Date Performed	4/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2013

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Freeway Number of Lanes, N: 2	☐ Yes ☐ On
☑ No ☐ Off	Ramp Number of Lanes, N: 1	☑ No ☐ Off
L_{up} = ft	Acceleration Lane Length, L_A: 725	L_{down} = ft
V_u = veh/h	Deceleration Lane Length L_D:	V_D = veh/h
	Freeway Volume, V_F: 711	
	Ramp Volume, V_R: 282	
	Freeway Free-Flow Speed, S_{FF}: 55.0	
	Ramp Free-Flow Speed, S_{FR}: 25.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	711	0.90	Level	2	0	0.990	1.00	798
Ramp	282	0.90	Level	4	0	0.980	1.00	320
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 1.000 using Equation (Exhibit 13-6)

V_{12} = 798 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	1118	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	1118	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = 9.5 (pc/mi/ln)

LOS = A (Exhibit 13-2)

Speed Determination

M_S = 0.297 (Exibit 13-11)

S_R= 51.1 mph (Exhibit 13-11)

S_0= N/A mph (Exhibit 13-11)

S = 51.1 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-526 EB
Agency or Company	Atkins	Junction	3340-EB On from US17 NB
Date Performed	4/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2013

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Freeway Number of Lanes, N: 2	☐ Yes ☐ On
☑ No ☐ Off	Ramp Number of Lanes, N: 1	☑ No ☐ Off
L_{up} = ft	Acceleration Lane Length, L_A: 550	L_{down} = ft
V_u = veh/h	Deceleration Lane Length L_D:	V_D = veh/h
	Freeway Volume, V_F: 674	
	Ramp Volume, V_R: 16	
	Freeway Free-Flow Speed, S_{FF}: 55.0	
	Ramp Free-Flow Speed, S_{FR}: 45.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	674	0.90	Level	9	0	0.957	1.00	783
Ramp	16	0.90	Level	6	0	0.971	1.00	18
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 1.000 using Equation (Exhibit 13-6)

V_{12} = 783 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	801	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	801	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = 8.3 (pc/mi/ln)

LOS = A (Exhibit 13-2)

Speed Determination

M_S = 0.280 (Exibit 13-11)

S_R= 51.4 mph (Exhibit 13-11)

S_0= N/A mph (Exhibit 13-11)

S = 51.4 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-526 EB
Agency or Company	Atkins	Junction	3340-EB On from US17 NB
Date Performed	4/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2013

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Number of Lanes, N: 2	☐ Yes ☐ On
☑ No ☐ Off	Acceleration Lane Length, L_A: 550	☑ No ☐ Off
L_{up} = ft	Deceleration Lane Length L_D:	L_{down} = ft
V_u = veh/h	Freeway Volume, V_F: 993	V_D = veh/h
	Ramp Volume, V_R: 21	
	Freeway Free-Flow Speed, S_{FF}: 55.0	
	Ramp Free-Flow Speed, S_{FR}: 45.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	993	0.90	Level	3	0	0.985	1.00	1120
Ramp	21	0.90	Level	5	0	0.976	1.00	24
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 1.000 using Equation (Exhibit 13-6)

V_{12} = 1120 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	1144	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	1144	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = 10.9 (pc/mi/ln)

LOS = B (Exhibit 13-2)

Speed Determination

M_S = 0.284 (Exibit 13-11)

S_R= 51.3 mph (Exhibit 13-11)

S_0= N/A mph (Exhibit 13-11)

S = 51.3 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-526 WB
Agency or Company	Atkins	Junction	4010-WB Off to US17 NB
Date Performed	3/20/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2013

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Number of Lanes, N	2	Downstream Adj Ramp	
☐ Yes	☐ On	Acceleration Lane Length, L_A		☐ Yes	☐ On
☑ No	☐ Off	Deceleration Lane Length L_D	300	☑ No	☐ Off
L_{up} =	ft	Freeway Volume, V_F	1023	L_{down} =	ft
V_u =	veh/h	Ramp Volume, V_R	298	V_D =	veh/h
		Freeway Free-Flow Speed, S_{FF}	55.0		
		Ramp Free-Flow Speed, S_{FR}	45.0		

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	1023	0.90	Level	7	0	0.966	1.00	1176
Ramp	298	0.90	Level	14	0	0.935	1.00	354
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 1.000 using Equation (Exhibit 13-7)

V_{12} = 1176 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	1176	Exhibit 13-8	4500	No
$V_{FO} = V_F - V_R$	822	Exhibit 13-8	4500	No
V_R	354	Exhibit 13-10	2100	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	1176	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = 11.7 (pc/mi/ln)

LOS = B (Exhibit 13-2)

Speed Determination

D_s = 0.330 (Exhibit 13-12)

S_R= 50.7 mph (Exhibit 13-12)

S_0= N/A mph (Exhibit 13-12)

S = 50.7 mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-526 WB
Agency or Company	Atkins	Junction	4010-WB Off to US17 NB
Date Performed	3/20/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2013

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Number of Lanes, N	2	Downstream Adj Ramp	
☐ Yes	☐ On	Acceleration Lane Length, L_A		☐ Yes	☐ On
☑ No	☐ Off	Deceleration Lane Length L_D	300	☑ No	☐ Off
L_{up} =	ft	Freeway Volume, V_F	884	L_{down} =	ft
V_u =	veh/h	Ramp Volume, V_R	426	V_D =	veh/h
		Freeway Free-Flow Speed, S_{FF}	55.0		
		Ramp Free-Flow Speed, S_{FR}	45.0		

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	884	0.90	Level	9	0	0.957	1.00	1026
Ramp	426	0.90	Level	7	0	0.966	1.00	490
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 1.000 using Equation (Exhibit 13-7)

V_{12} = 1026 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	1026	Exhibit 13-8	4500	No
$V_{FO} = V_F - V_R$	536	Exhibit 13-8	4500	No
V_R	490	Exhibit 13-10	2100	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	1026	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = 10.4 (pc/mi/ln)

LOS = B (Exhibit 13-2)

Speed Determination

D_s = 0.342 (Exhibit 13-12)

S_R= 50.6 mph (Exhibit 13-12)

S_0= N/A mph (Exhibit 13-12)

S = 50.6 mph (Exhibit 13-13)

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-526 WB*
Agency or Company	*Atkins*	From/To	*4015-US17 NB off to US17 NB On*
Date Performed	*4/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2013*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*725*	veh/h	Peak-Hour Factor, PHF	*0.90*	
AADT		veh/day	%Trucks and Buses, P_T	*4*	
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*	
Peak-Hr Direction Prop, D			General Terrain:	*Level*	
DDHV = AADT x K x D		veh/h	Grade % Length	*mi*	
			Up/Down %		

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.980*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*55.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*55.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*411*	pc/h/ln
S	*55.0*	mph
D = v_p / S	*7.5*	pc/mi/ln
LOS	*A*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-526 WB*
Agency or Company	*Atkins*	From/To	*4015-US17 NB off to US17 NB On*
Date Performed	*4/25/2014*	Jurisdiction	
Analysis Time Period	*PM Peak*	Analysis Year	*2013*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*458*	veh/h	Peak-Hour Factor, PHF	*0.90*	
AADT		veh/day	%Trucks and Buses, P_T	*11*	
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*	
Peak-Hr Direction Prop, D			General Terrain:	*Level*	
DDHV = AADT x K x D		veh/h	Grade % Length	*mi*	
			Up/Down %		

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.948*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*55.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*55.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*268*	pc/h/ln
S	*55.0*	mph
D = v_p / S	*4.9*	pc/mi/ln
LOS	*A*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-526 WB
Agency or Company	Atkins	Junction	4020-WB On from US17 NB
Date Performed	4/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2013

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Freeway Number of Lanes, N: 2	☐ Yes ☐ On
☑ No ☐ Off	Ramp Number of Lanes, N: 1	☑ No ☐ Off
L_{up} = ft	Acceleration Lane Length, L_A: 775	L_{down} = ft
V_u = veh/h	Deceleration Lane Length L_D:	V_D = veh/h
	Freeway Volume, V_F: 725	
	Ramp Volume, V_R: 855	
	Freeway Free-Flow Speed, S_{FF}: 55.0	
	Ramp Free-Flow Speed, S_{FR}: 25.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	725	0.90	Level	4	0	0.980	1.00	822
Ramp	855	0.90	Level	6	0	0.971	1.00	979
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 1.000 using Equation (Exhibit 13-6)

V_{12} = 822 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	1801	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	1801	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = 14.2 (pc/mi/ln)

LOS = B (Exhibit 13-2)

Speed Determination

M_S = 0.306 (Exibit 13-11)

S_R= 51.0 mph (Exhibit 13-11)

S_0= N/A mph (Exhibit 13-11)

S = 51.0 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-526 WB
Agency or Company	Atkins	Junction	4020-WB On from US17 NB
Date Performed	4/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2013

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Freeway Number of Lanes, N: 2	☐ Yes ☐ On
☑ No ☐ Off	Ramp Number of Lanes, N: 1	☑ No ☐ Off
L_{up} = ft	Acceleration Lane Length, L_A: 775	L_{down} = ft
V_u = veh/h	Deceleration Lane Length L_D:	V_D = veh/h
	Freeway Volume, V_F: 458	
	Ramp Volume, V_R: 835	
	Freeway Free-Flow Speed, S_{FF}: 55.0	
	Ramp Free-Flow Speed, S_{FR}: 25.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	458	0.90	Level	11	0	0.948	1.00	537
Ramp	835	0.90	Level	5	0	0.976	1.00	951
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 1.000 using Equation (Exhibit 13-6)

V_{12} = 537 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	1488	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	1488	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = 11.8 (pc/mi/ln)

LOS = B (Exhibit 13-2)

Speed Determination

M_S = 0.300 (Exibit 13-11)

S_R= 51.1 mph (Exhibit 13-11)

S_0= N/A mph (Exhibit 13-11)

S = 51.1 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-526 WB*
Agency or Company	*Atkins*	From/To	*4030-US17 to US17/Hungryneck*
Date Performed	*4/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2013*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*1580*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*5*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.976*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*55.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*55.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*900*	pc/h/ln
S	*55.0*	mph
D = v_p / S	*16.4*	pc/mi/ln
LOS	*B*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-526 WB*
Agency or Company	*Atkins*	From/To	*4030-US17 to US17/Hungryneck*
Date Performed	*4/25/2014*	Jurisdiction	
Analysis Time Period	*PM Peak*	Analysis Year	*2013*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*1293*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*7*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.966*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*55.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*55.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*743*	pc/h/ln
S	*55.0*	mph
D = v_p / S	*13.5*	pc/mi/ln
LOS	*B*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-526 WB
Agency or Company	Atkins	Junction	4020-WB On from US17/Hungrynec
Date Performed	4/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2013

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Number of Lanes, N: 2	☐ Yes ☐ On
☑ No ☐ Off	Acceleration Lane Length, L_A: 425	☑ No ☐ Off
L_{up} = ft	Deceleration Lane Length L_D:	L_{down} = ft
V_u = veh/h	Freeway Volume, V_F: 1580	V_D = veh/h
	Ramp Volume, V_R: 811	
	Freeway Free-Flow Speed, S_{FF}: 55.0	
	Ramp Free-Flow Speed, S_{FR}: 45.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	1580	0.90	Level	5	0	0.976	1.00	1799
Ramp	811	0.90	Level	25	0	0.889	1.00	1014
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 1.000 using Equation (Exhibit 13-6)

V_{12} = 1799 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * $V_{12}/2$ ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	2813	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	2813	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = 24.3 (pc/mi/ln)

LOS = C (Exhibit 13-2)

Speed Determination

M_S = 0.348 (Exibit 13-11)

S_R= 50.5 mph (Exhibit 13-11)

S_0= N/A mph (Exhibit 13-11)

S = 50.5 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * $V_{12}/2$ ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-526 WB
Agency or Company	Atkins	Junction	4020-WB On from US17/Hungrynec
Date Performed	4/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2013

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Number of Lanes, N: 2	☐ Yes ☐ On
☑ No ☐ Off	Acceleration Lane Length, L_A: 425	☑ No ☐ Off
L_{up} = ft	Deceleration Lane Length L_D:	L_{down} = ft
V_u = veh/h	Freeway Volume, V_F: 1293	V_D = veh/h
	Ramp Volume, V_R: 1172	
	Freeway Free-Flow Speed, S_{FF}: 55.0	
	Ramp Free-Flow Speed, S_{FR}: 45.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	1293	0.90	Level	7	0	0.966	1.00	1487
Ramp	1172	0.90	Level	14	0	0.935	1.00	1393
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 1.000 using Equation (Exhibit 13-6)

V_{12} = 1487 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * $V_{12}/2$ ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	2880	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	2880	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = 24.6 (pc/mi/ln)

LOS = C (Exhibit 13-2)

Speed Determination

M_S = 0.352 (Exibit 13-11)

S_R= 50.4 mph (Exhibit 13-11)

S_0= N/A mph (Exhibit 13-11)

S = 50.4 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * $V_{12}/2$ ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-526 WB*
Agency or Company	*Atkins*	From/To	*4050-US17/Hungryneck to LongPt*
Date Performed	*4/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2013*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*2391*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*12*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.943*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*65.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*65.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1408*	pc/h/ln
S	*65.0*	mph
D = v_p / S	*21.7*	pc/mi/ln
LOS	*C*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-526 WB*
Agency or Company	*Atkins*	From/To	*4050-US17/Hungryneck to LongPt*
Date Performed	*4/25/2014*	Jurisdiction	
Analysis Time Period	*PM Peak*	Analysis Year	*2013*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*2465*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*10*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.952*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*65.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*65.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1438*	pc/h/ln
S	*65.0*	mph
D = v_p / S	*22.1*	pc/mi/ln
LOS	*C*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-526 WB
Agency or Company	Atkins	Junction	4060-WB Off to Long Point
Date Performed	3/20/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2013

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Number of Lanes, N	2	Downstream Adj Ramp	
☐ Yes	☐ On	Acceleration Lane Length, L_A		☐ Yes	☐ On
☑ No	☐ Off	Deceleration Lane Length L_D	250	☑ No	☐ Off
L_{up} =	ft	Freeway Volume, V_F	2391	L_{down} =	ft
V_u =	veh/h	Ramp Volume, V_R	500	V_D =	veh/h
		Freeway Free-Flow Speed, S_{FF}	65.0		
		Ramp Free-Flow Speed, S_{FR}	45.0		

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	2391	0.90	Level	12	0	0.943	1.00	2816
Ramp	500	0.90	Level	16	0	0.926	1.00	600
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 1.000 using Equation (Exhibit 13-7)

V_{12} = 2816 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	2816	Exhibit 13-8	4700	No
$V_{FO} = V_F - V_R$	2216	Exhibit 13-8	4700	No
V_R	600	Exhibit 13-10	2100	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	2816	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = 26.2 (pc/mi/ln)

LOS = C (Exhibit 13-2)

Speed Determination

D_s = 0.352 (Exhibit 13-12)

S_R= 56.9 mph (Exhibit 13-12)

S_0= N/A mph (Exhibit 13-12)

S = 56.9 mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-526 WB
Agency or Company	Atkins	Junction	4060-WB Off to Long Point
Date Performed	3/20/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2013

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Number of Lanes, N: 2	☐ Yes ☐ On
☑ No ☐ Off	Acceleration Lane Length, L_A:	☑ No ☐ Off
L_{up} = ft	Deceleration Lane Length L_D: 250	L_{down} = ft
V_u = veh/h	Freeway Volume, V_F: 2465	V_D = veh/h
	Ramp Volume, V_R: 1141	
	Freeway Free-Flow Speed, S_{FF}: 65.0	
	Ramp Free-Flow Speed, S_{FR}: 45.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	2465	0.90	Level	10	0	0.952	1.00	2876
Ramp	1141	0.90	Level	12	0	0.943	1.00	1344
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 1.000 using Equation (Exhibit 13-7)

V_{12} = 2876 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	2876	Exhibit 13-8	4700	No
$V_{FO} = V_F - V_R$	1532	Exhibit 13-8	4700	No
V_R	1344	Exhibit 13-10	2100	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	2876	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = 26.7 (pc/mi/ln)

LOS = C (Exhibit 13-2)

Speed Determination

D_s = 0.419 (Exhibit 13-12)

S_R= 55.4 mph (Exhibit 13-12)

S_0= N/A mph (Exhibit 13-12)

S = 55.4 mph (Exhibit 13-13)

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-526 WB*
Agency or Company	*Atkins*	From/To	*4065-LongPt Off to LongPtEB On*
Date Performed	*4/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2013*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*1891*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*11*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.948*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*65.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*65.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1108*	pc/h/ln
S	*65.0*	mph
D = v_p / S	*17.0*	pc/mi/ln
LOS	*B*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-526 WB*
Agency or Company	*Atkins*	From/To	*4065-LongPt Off to LongPtEB On*
Date Performed	*4/25/2014*	Jurisdiction	
Analysis Time Period	*PM Peak*	Analysis Year	*2013*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*1324*	veh/h	Peak-Hour Factor, PHF	*0.90*	
AADT		veh/day	%Trucks and Buses, P_T	*9*	
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*	
Peak-Hr Direction Prop, D			General Terrain:	*Level*	
DDHV = AADT x K x D		veh/h	Grade % Length	*mi*	
			Up/Down %		

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.957*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*65.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*65.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*769*	pc/h/ln
S	*65.0*	mph
D = v_p / S	*11.8*	pc/mi/ln
LOS	*B*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-526 WB
Agency or Company	Atkins	Junction	4070-WB On from Long Point EB
Date Performed	4/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2013

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Number of Lanes, N: 2	☐ Yes ☐ On
☑ No ☐ Off	Acceleration Lane Length, L_A: 950	☑ No ☐ Off
L_{up} = ft	Deceleration Lane Length L_D:	L_{down} = ft
V_u = veh/h	Freeway Volume, V_F: 1891	V_D = veh/h
	Ramp Volume, V_R: 494	
	Freeway Free-Flow Speed, S_{FF}: 65.0	
	Ramp Free-Flow Speed, S_{FR}: 25.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	1891	0.90	Level	11	0	0.948	1.00	2217
Ramp	494	0.90	Level	17	0	0.922	1.00	596
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 1.000 using Equation (Exhibit 13-6)

V_{12} = 2217 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	2813	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	2813	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = 21.2 (pc/mi/ln)

LOS = C (Exhibit 13-2)

Speed Determination

M_S = 0.338 (Exibit 13-11)

S_R= 57.2 mph (Exhibit 13-11)

S_0= N/A mph (Exhibit 13-11)

S = 57.2 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-526 WB
Agency or Company	Atkins	Junction	4070-WB On from Long Point EB
Date Performed	4/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2013

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Number of Lanes, N: 2	☐ Yes ☐ On
☑ No ☐ Off	Acceleration Lane Length, L_A: 950	☑ No ☐ Off
L_{up} = ft	Deceleration Lane Length L_D:	L_{down} = ft
V_u = veh/h	Freeway Volume, V_F: 1324	V_D = veh/h
	Ramp Volume, V_R: 549	
	Freeway Free-Flow Speed, S_{FF}: 65.0	
	Ramp Free-Flow Speed, S_{FR}: 25.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	1324	0.90	Level	9	0	0.957	1.00	1537
Ramp	549	0.90	Level	19	0	0.913	1.00	668
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 1.000 using Equation (Exhibit 13-6)

V_{12} = 1537 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	2205	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	2205	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = 16.4 (pc/mi/ln)

LOS = B (Exhibit 13-2)

Speed Determination

M_S = 0.309 (Exibit 13-11)

S_R= 57.9 mph (Exhibit 13-11)

S_0= N/A mph (Exhibit 13-11)

S = 57.9 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-526 WB
Agency or Company	Atkins	Junction	4080-WB On from Long Point WB
Date Performed	4/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2013

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Number of Lanes, N: 2	☐ Yes ☐ On
☑ No ☐ Off	Acceleration Lane Length, L_A: 1025	☑ No ☐ Off
L_{up} = ft	Deceleration Lane Length L_D:	L_{down} = ft
V_u = veh/h	Freeway Volume, V_F: 2385	V_D = veh/h
	Ramp Volume, V_R: 1368	
	Freeway Free-Flow Speed, S_{FF}: 65.0	
	Ramp Free-Flow Speed, S_{FR}: 45.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	2385	0.90	Level	12	0	0.943	1.00	2809
Ramp	1368	0.90	Level	5	0	0.976	1.00	1558
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 1.000 using Equation (Exhibit 13-6)

V_{12} = 2809 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	4367	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	4367	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = 32.4 (pc/mi/ln)

LOS = D (Exhibit 13-2)

Speed Determination

M_S = 0.536 (Exibit 13-11)

S_R= 52.7 mph (Exhibit 13-11)

S_0= N/A mph (Exhibit 13-11)

S = 52.7 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-526 WB
Agency or Company	Atkins	Junction	4080-WB On from Long Point WB
Date Performed	4/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2013

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Number of Lanes, N: 2	☐ Yes ☐ On
☑ No ☐ Off	Acceleration Lane Length, L_A: 1025	☑ No ☐ Off
L_{up} = ft	Deceleration Lane Length L_D:	L_{down} = ft
V_u = veh/h	Freeway Volume, V_F: 1873	V_D = veh/h
	Ramp Volume, V_R: 993	
	Freeway Free-Flow Speed, S_{FF}: 65.0	
	Ramp Free-Flow Speed, S_{FR}: 45.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	1873	0.90	Level	12	0	0.943	1.00	2206
Ramp	993	0.90	Level	5	0	0.976	1.00	1131
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 1.000 using Equation (Exhibit 13-6)

V_{12} = 2206 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	3337	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	3337	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = 24.6 (pc/mi/ln)

LOS = C (Exhibit 13-2)

Speed Determination

M_S = 0.338 (Exibit 13-11)

S_R= 57.2 mph (Exhibit 13-11)

S_0= N/A mph (Exhibit 13-11)

S = 57.2 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-526 WB*
Agency or Company	*Atkins*	From/To	*4090-Long Point to Island Park*
Date Performed	*4/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2013*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs				
Volume, V	*3753*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*10*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length	*mi*
			Up/Down %	

Calculate Flow Adjustments			
f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.952*

Speed Inputs			Calc Speed Adj and FFS		
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f_{LW}		mph
Number of Lanes, N	*2*		f_{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	*65.0*	mph	FFS	*65.0*	mph
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures			Design (N)	
Operational (LOS)			Design (N)	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*2189*	pc/h/ln	Design LOS	
			v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h/ln
S	*56.2*	mph	S	mph
D = v_p / S	*39.0*	pc/mi/ln	D = v_p / S	pc/mi/ln
LOS	*E*		Required Number of Lanes, N	

Glossary		Factor Location	
N - Number of lanes	S - Speed	E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
V - Hourly volume	D - Density	E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 11-18	TRD - Page 11-11
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 11-2, 11-3	
DDHV - Directional design hour volume			

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-526 WB*
Agency or Company	*Atkins*	From/To	*4090-Long Point to Island Park*
Date Performed	*4/25/2014*	Jurisdiction	
Analysis Time Period	*PM Peak*	Analysis Year	*2013*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs				
Volume, V	*2866*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*9*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.957*

Speed Inputs			Calc Speed Adj and FFS		
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f_{LW}		mph
Number of Lanes, N	*2*		f_{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	*65.0*	mph	FFS	*65.0*	mph
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures			Design (N)	
Operational (LOS)			Design (N)	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1664*	pc/h/ln	Design LOS	
S	*64.0*	mph	v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h/ln
D = v_p / S	*26.0*	pc/mi/ln	S	mph
LOS	*C*		D = v_p / S	pc/mi/ln
			Required Number of Lanes, N	

Glossary		Factor Location	
N - Number of lanes	S - Speed	E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
V - Hourly volume	D - Density	E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 11-18	TRD - Page 11-11
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 11-2, 11-3	
DDHV - Directional design hour volume			

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-526 WB
Agency or Company	Atkins	Junction	4100-WB Off to Island Park
Date Performed	3/20/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2013

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Number of Lanes, N	2	Downstream Adj Ramp	
☐ Yes	☐ On	Acceleration Lane Length, L_A		☐ Yes	☐ On
☑ No	☐ Off	Deceleration Lane Length L_D	775	☑ No	☐ Off
L_{up} =	ft	Freeway Volume, V_F	3753	L_{down} =	ft
V_u =	veh/h	Ramp Volume, V_R	1054	V_D =	veh/h
		Freeway Free-Flow Speed, S_{FF}	65.0		
		Ramp Free-Flow Speed, S_{FR}	25.0		

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	3753	0.90	Level	10	0	0.952	1.00	4379
Ramp	1054	0.90	Level	12	0	0.943	1.00	1241
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 1.000 using Equation (Exhibit 13-7)

V_{12} = 4379 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	4379	Exhibit 13-8	4700	No
$V_{FO} = V_F - V_R$	3138	Exhibit 13-8	4700	No
V_R	1241	Exhibit 13-10	1900	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	4379	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = 34.9 (pc/mi/ln)

LOS = D (Exhibit 13-2)

Speed Determination

D_s = 0.670 (Exhibit 13-12)

S_R= 49.6 mph (Exhibit 13-12)

S_0= N/A mph (Exhibit 13-12)

S = 49.6 mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-526 WB
Agency or Company	Atkins	Junction	4100-WB Off to Island Park
Date Performed	3/20/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2013

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Number of Lanes, N	2	Downstream Adj Ramp	
☐ Yes	☐ On	Acceleration Lane Length, L_A		☐ Yes	☐ On
☑ No	☐ Off	Deceleration Lane Length L_D	775	☑ No	☐ Off
L_{up} =	ft	Freeway Volume, V_F	2866	L_{down} =	ft
V_u =	veh/h	Ramp Volume, V_R	571	V_D =	veh/h
		Freeway Free-Flow Speed, S_{FF}	65.0		
		Ramp Free-Flow Speed, S_{FR}	25.0		

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	2866	0.90	Level	9	0	0.957	1.00	3328
Ramp	571	0.90	Level	8	0	0.962	1.00	660
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 1.000 using Equation (Exhibit 13-7)

V_{12} = 3328 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	3328	Exhibit 13-8	4700	No
$V_{FO} = V_F - V_R$	2668	Exhibit 13-8	4700	No
V_R	660	Exhibit 13-10	1900	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	3328	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = 25.9 (pc/mi/ln)

LOS = C (Exhibit 13-2)

Speed Determination

D_s = 0.617 (Exhibit 13-12)

S_R= 50.8 mph (Exhibit 13-12)

S_0= N/A mph (Exhibit 13-12)

S = 50.8 mph (Exhibit 13-13)

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-526 WB*
Agency or Company	*Atkins*	From/To	*4105 - Is. Pk Off to Is. Pk On*
Date Performed	*4/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2013*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*2699*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*8*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.962*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*65.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*65.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1559*	pc/h/ln
S	*64.6*	mph
D = v_p / S	*24.1*	pc/mi/ln
LOS	*C*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-526 WB*
Agency or Company	*Atkins*	From/To	*4105 - Is. Pk Off to Is. Pk On*
Date Performed	*4/25/2014*	Jurisdiction	
Analysis Time Period	*PM Peak*	Analysis Year	*2013*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*2295*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*10*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.952*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*65.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*65.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1339*	pc/h/ln
S	*65.0*	mph
D = v_p / S	*20.6*	pc/mi/ln
LOS	*C*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-526 WB
Agency or Company	Atkins	Junction	4110-WB On from Island Park Dr
Date Performed	4/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2013

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Freeway Number of Lanes, N: 2	☐ Yes ☐ On
☑ No ☐ Off	Ramp Number of Lanes, N: 1	☑ No ☐ Off
L_{up} = ft	Acceleration Lane Length, L_A: 1400	L_{down} = ft
V_u = veh/h	Deceleration Lane Length L_D:	V_D = veh/h
	Freeway Volume, V_F: 2699	
	Ramp Volume, V_R: 543	
	Freeway Free-Flow Speed, S_{FF}: 65.0	
	Ramp Free-Flow Speed, S_{FR}: 45.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	2699	0.90	Level	8	0	0.962	1.00	3119
Ramp	543	0.90	Level	3	0	0.985	1.00	612
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 1.000 using Equation (Exhibit 13-6)

V_{12} = 3119 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	3731	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	3731	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = 25.5 (pc/mi/ln)

LOS = C (Exhibit 13-2)

Speed Determination

M_S = 0.358 (Exibit 13-11)

S_R= 56.8 mph (Exhibit 13-11)

S_0= N/A mph (Exhibit 13-11)

S = 56.8 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-526 WB
Agency or Company	Atkins	Junction	4110-WB On from Island Park Dr
Date Performed	4/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2013

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Freeway Number of Lanes, N: 2	☐ Yes ☐ On
☑ No ☐ Off	Ramp Number of Lanes, N: 1	☑ No ☐ Off
L_{up} = ft	Acceleration Lane Length, L_A: 1400	L_{down} = ft
V_u = veh/h	Deceleration Lane Length L_D:	V_D = veh/h
	Freeway Volume, V_F: 2295	
	Ramp Volume, V_R: 630	
	Freeway Free-Flow Speed, S_{FF}: 65.0	
	Ramp Free-Flow Speed, S_{FR}: 45.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	2295	0.90	Level	10	0	0.952	1.00	2678
Ramp	630	0.90	Level	6	0	0.971	1.00	721
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 1.000 using Equation (Exhibit 13-6)

V_{12} = 2678 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	3399	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	3399	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = 22.9 (pc/mi/ln)

LOS = C (Exhibit 13-2)

Speed Determination

M_S = 0.312 (Exibit 13-11)

S_R= 57.8 mph (Exhibit 13-11)

S_0= N/A mph (Exhibit 13-11)

S = 57.8 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-526 WB*
Agency or Company	*Atkins*	From/To	*4120-IslandParktoClementsFerry*
Date Performed	*4/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2013*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*3242*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*8*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.962*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*65.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*65.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1873*	pc/h/ln
S	*61.8*	mph
D = v_p / S	*30.3*	pc/mi/ln
LOS	*D*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-526 WB*
Agency or Company	*Atkins*	From/To	*4120-IslandParktoClementsFerry*
Date Performed	*4/25/2014*	Jurisdiction	
Analysis Time Period	*PM Peak*	Analysis Year	*2013*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*2925*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*9*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.957*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*65.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*65.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1698*	pc/h/ln
S	*63.7*	mph
D = v_p / S	*26.6*	pc/mi/ln
LOS	*D*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-526 WB
Agency or Company	Atkins	Junction	4130-WB Off to Clements Ferry
Date Performed	3/20/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2013

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Number of Lanes, N	2	Downstream Adj Ramp	
☐ Yes	☐ On	Acceleration Lane Length, L_A		☐ Yes	☐ On
☑ No	☐ Off	Deceleration Lane Length L_D	240	☑ No	☐ Off
L_{up} =	ft	Freeway Volume, V_F	3242	L_{down} =	ft
		Ramp Volume, V_R	425		
V_u =	veh/h	Freeway Free-Flow Speed, S_{FF}	60.0	V_D =	veh/h
		Ramp Free-Flow Speed, S_{FR}	45.0		

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	3242	0.90	Level	8	0	0.962	1.00	3746
Ramp	425	0.90	Level	21	0	0.905	1.00	522
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 1.000 using Equation (Exhibit 13-7)

V_{12} = 3746 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	3746	Exhibit 13-8	4600	No
$V_{FO} = V_F - V_R$	3224	Exhibit 13-8	4600	No
V_R	522	Exhibit 13-10	2100	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	3746	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = 34.3 (pc/mi/ln)

LOS = D (Exhibit 13-2)

Speed Determination

D_s = 0.345 (Exhibit 13-12)

S_R= 53.8 mph (Exhibit 13-12)

S_0= N/A mph (Exhibit 13-12)

S = 53.8 mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-526 WB
Agency or Company	Atkins	Junction	4130-WB Off to Clements Ferry
Date Performed	3/20/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2013

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Number of Lanes, N	2	Downstream Adj Ramp	
☐ Yes	☐ On	Acceleration Lane Length, L_A		☐ Yes	☐ On
☑ No	☐ Off	Deceleration Lane Length L_D	240	☑ No	☐ Off
L_{up} =	ft	Freeway Volume, V_F	2925	L_{down} =	ft
		Ramp Volume, V_R	352		
V_u =	veh/h	Freeway Free-Flow Speed, S_{FF}	60.0	V_D =	veh/h
		Ramp Free-Flow Speed, S_{FR}	45.0		

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	2925	0.90	Level	9	0	0.957	1.00	3396
Ramp	352	0.90	Level	15	0	0.930	1.00	420
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 1.000 using Equation (Exhibit 13-7)

V_{12} = 3396 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	3396	Exhibit 13-8	4600	No
$V_{FO} = V_F - V_R$	2976	Exhibit 13-8	4600	No
V_R	420	Exhibit 13-10	2100	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	3396	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = 31.3 (pc/mi/ln)

LOS = D (Exhibit 13-2)

Speed Determination

D_s = 0.336 (Exhibit 13-12)

S_R= 54.0 mph (Exhibit 13-12)

S_0= N/A mph (Exhibit 13-12)

S = 54.0 mph (Exhibit 13-13)

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-526 WB*
Agency or Company	*Atkins*	From/To	*4135-ClFerry Off to ClFerry On*
Date Performed	*4/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2013*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*2817*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*5*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.976*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*60.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*60.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1604*	pc/h/ln
S	*60.0*	mph
D = v_p / S	*26.7*	pc/mi/ln
LOS	*D*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-526 WB*
Agency or Company	*Atkins*	From/To	*4135-ClFerry Off to ClFerry On*
Date Performed	*4/25/2014*	Jurisdiction	
Analysis Time Period	*PM Peak*	Analysis Year	*2013*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*2573*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*8*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.962*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*60.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*60.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1487*	pc/h/ln
S	*60.0*	mph
D = v_p / S	*24.8*	pc/mi/ln
LOS	*C*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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FREEWAY RAMP ADD OR DROP LANE ANALYSIS

ATKINS

General Information

Date Performed:	3/20/2014	Freeway/Direction	I-526 WB
Analysis Year	2013	Junction	From Clements Ferry
Analysis Time Period:	AM Peak	Segment ID	4140
Project Description:	Navy Base ICTF		

Inputs

	Freeway Upstream of Ramp	Freeway Downstream of Ramp	Ramp
Number of Lanes, N	2	3	1
Free-Flow Speed, FFS (mph)	60	60	45
Volume, V (veh/h)	2,817	3,740	923
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	5%	9%	18%
%RVs, P_R	0%	0%	0%

Performance Measures

	Freeway Upstream Ramp	Freeway Downstream Ramp	Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.98	0.96	0.92
Demand Flow Rate, v_p (pc/h/ln)	1,604	1,448	1,118
Capacity Flow Rate, c (pc/h/ln)	2,300	2,300	2,100
v/c ratio	0.70	0.63	0.53
Density, D_{MD} (pc/mi/ln)	28.1	25.3	19.6
LOS	D	C	B

Formulas and Reference Material

$$f_{HV} = \frac{1}{1+P_T(E_T-1)+P_R(E_R-1)}$$ HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P}$$ HCM 2010, Equation 11-2

$$D_{MD} = \frac{0.0175*v_f}{N}$$ HCM 2010, Equation 13-26

Basic Freeway Segments Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
75	2,400
70	2,400
65	2,350
60	2,300
55	2,250

Source: HCM 2010, Exhibit 11-17

Ramp Roadways Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

Diverge LOS Thresholds

LOS	Density (pc/mi/ln)
A	≤10
B	>10-20
C	>20-28
D	>28-35
E	>35
F	v/c > 1

Source: HCM 2010, Exhibit 13-2

FREEWAY RAMP ADD OR DROP LANE ANALYSIS

ATKINS

General Information

Date Performed:	3/20/2014	Freeway/Direction	I-526 WB
Analysis Year	2013	Junction	From Clements Ferry
Analysis Time Period:	PM Peak	Segment ID	4140
Project Description:	Navy Base ICTF		

Inputs

	Freeway Upstream of Ramp	Freeway Downstream of Ramp	Ramp
Number of Lanes, N	2	3	1
Free-Flow Speed, FFS (mph)	60	60	45
Volume, V (veh/h)	2,573	2,915	342
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	8%	13%	50%
%RVs, P_R	0%	0%	0%

Performance Measures

	Freeway Upstream Ramp	Freeway Downstream Ramp	Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.96	0.94	0.80
Demand Flow Rate, v_p (pc/h/ln)	1,487	1,150	475
Capacity Flow Rate, c (pc/h/ln)	2,300	2,300	2,100
v/c ratio	0.65	0.50	0.23
Density, D_{MD} (pc/mi/ln)	26.0	20.1	8.3
LOS	C	C	A

Formulas and Reference Material

$$f_{HV} = \frac{1}{1+P_T(E_T-1)+P_R(E_R-1)}$$ HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P}$$ HCM 2010, Equation 11-2

$$D_{MD} = \frac{0.0175*v_f}{N}$$ HCM 2010, Equation 13-26

Basic Freeway Segments Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
75	2,400
70	2,400
65	2,350
60	2,300
55	2,250

Source: HCM 2010, Exhibit 11-17

Ramp Roadways Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

Diverge LOS Thresholds

LOS	Density (pc/mi/ln)
A	≤10
B	>10-20
C	>20-28
D	>28-35
E	>35
F	v/c > 1

Source: HCM 2010, Exhibit 13-2

BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-526 WB*
Agency or Company	*Atkins*	From/To	*4150-ClementsFerry to Virginia*
Date Performed	*4/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2013*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*3740*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*9*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.957*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*60.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*60.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*2171*	pc/h/ln
S	*54.1*	mph
D = v_p / S	*40.1*	pc/mi/ln
LOS	*E*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-526 WB*
Agency or Company	*Atkins*	From/To	*4150-ClementsFerry to Virginia*
Date Performed	*4/25/2014*	Jurisdiction	
Analysis Time Period	*PM Peak*	Analysis Year	*2013*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*2915*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*13*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.939*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*60.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*60.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1725*	pc/h/ln
S	*59.7*	mph
D = v_p / S	*28.9*	pc/mi/ln
LOS	*D*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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Navy Base ICTF

FREEWAY WEAVING WORKSHEET

General Information

Analyst	AJR
Agency/Company	Atkins
Date Performed	3/20/2014
Analysis Time Period	AM Peak

Site Information

Freeway/Dir of Travel	I-526 WB
Weaving Segment Location	4160 - Virginia to Rhett
Analysis Year	2013

Project Description *Navy Base ICTF*

Inputs

Weaving configuration	One-Sided	Segment type	Freeway
Weaving number of lanes, N	3	Freeway minimum speed, S_{MIN}	15
Weaving segment length, L_S	1415ft	Freeway maximum capacity, C_{IFL}	2300
Freeway free-flow speed, FFS	60 mph	Terrain type	Level

Conversions to pc/h Under Base Conditions

	V (veh/h)	PHF	Truck (%)	RV (%)	E_T	E_R	f_{HV}	f_p	v (pc/h)
V_{FF}	2742	0.90	9	0	1.5	1.2	0.957	1.00	3184
V_{RF}	85	0.90	42	0	1.5	1.2	0.826	1.00	114
V_{FR}	998	0.90	6	0	1.5	1.2	0.971	1.00	1142
V_{RR}	31	0.90	29	0	1.5	1.2	0.873	1.00	39
V_{NW}	3223							V =	4479
V_W	1256								
VR	0.280								

Configuration Characteristics

Minimum maneuver lanes, N_{WL}	2 lc	Minimum weaving lane changes, LC_{MIN}	1256 lc/h
Interchange density, ID	0.7 int/mi	Weaving lane changes, LC_W	1435 lc/h
Minimum RF lane changes, LC_{RF}	1 lc/pc	Non-weaving lane changes, LC_{NW}	853 lc/h
Minimum FR lane changes, LC_{FR}	1 lc/pc	Total lane changes, LC_{ALL}	2288 lc/h
Minimum RR lane changes, LC_{RR}	lc/pc	Non-weaving vehicle index, I_{NW}	319

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment flow rate, v	4479 pc/h	Weaving intensity factor, W	0.330
Weaving segment capacity, c_w	5733 veh/h	Weaving segment speed, S	45.1 mph
Weaving segment v/c ratio	0.748	Average weaving speed, S_W	48.8 mph
Weaving segment density, D	33.1 pc/mi/ln	Average non-weaving speed, S_{NW}	43.8 mph
Level of Service, LOS	D	Maximum weaving length, L_{MAX}	5375 ft

Notes

a. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments".
b. For volumes that exceed the weaving segment capacity, the level of service is "F".

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Navy Base ICTF

FREEWAY WEAVING WORKSHEET

General Information

Analyst	AJR
Agency/Company	Atkins
Date Performed	3/20/2014
Analysis Time Period	PM Peak

Site Information

Freeway/Dir of Travel	I-526 WB
Weaving Segment Location	4160 - Virginia to Rhett
Analysis Year	2013

Project Description *Navy Base ICTF*

Inputs

Weaving configuration	One-Sided	Segment type	Freeway
Weaving number of lanes, N	3	Freeway minimum speed, S_{MIN}	15
Weaving segment length, L_S	1415ft	Freeway maximum capacity, C_{IFL}	2300
Freeway free-flow speed, FFS	60 mph	Terrain type	Level

Conversions to pc/h Under Base Conditions

	V (veh/h)	PHF	Truck (%)	RV (%)	E_T	E_R	f_{HV}	f_p	v (pc/h)
V_{FF}	1977	0.90	15	0	1.5	1.2	0.930	1.00	2361
V_{RF}	549	0.90	22	0	1.5	1.2	0.901	1.00	677
V_{FR}	938	0.90	8	0	1.5	1.2	0.962	1.00	1084
V_{RR}	261	0.90	11	0	1.5	1.2	0.948	1.00	306
V_{NW}	2667							V =	4428
V_W	1761								
VR	0.398								

Configuration Characteristics

Minimum maneuver lanes, N_{WL}	2 lc	Minimum weaving lane changes, LC_{MIN}	1761 lc/h
Interchange density, ID	0.7 int/mi	Weaving lane changes, LC_W	1940 lc/h
Minimum RF lane changes, LC_{RF}	1 lc/pc	Non-weaving lane changes, LC_{NW}	739 lc/h
Minimum FR lane changes, LC_{FR}	1 lc/pc	Total lane changes, LC_{ALL}	2679 lc/h
Minimum RR lane changes, LC_{RR}	lc/pc	Non-weaving vehicle index, I_{NW}	264

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment flow rate, v	4428 pc/h	Weaving intensity factor, W	0.374
Weaving segment capacity, c_w	5300 veh/h	Weaving segment speed, S	42.9 mph
Weaving segment v/c ratio	0.777	Average weaving speed, S_W	47.8 mph
Weaving segment density, D	34.4 pc/mi/ln	Average non-weaving speed, S_{NW}	40.2 mph
Level of Service, LOS	D	Maximum weaving length, L_{MAX}	6655 ft

Notes

a. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments".
b. For volumes that exceed the weaving segment capacity, the level of service is "F".

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-526 WB*
Agency or Company	*Atkins*	From/To	*4165-Rhett Off to Rhett On*
Date Performed	*4/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2013*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*2827*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*10*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.952*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*60.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*60.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1649*	pc/h/ln
S	*60.0*	mph
D = v_p / S	*27.5*	pc/mi/ln
LOS	*D*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-526 WB*
Agency or Company	*Atkins*	From/To	*4165-Rhett Off to Rhett On*
Date Performed	*4/25/2014*	Jurisdiction	
Analysis Time Period	*PM Peak*	Analysis Year	*2013*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*2526*	veh/h	Peak-Hour Factor, PHF	*0.90*	
AADT		veh/day	%Trucks and Buses, P_T	*17*	
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*	
Peak-Hr Direction Prop, D			General Terrain:	*Level*	
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*	

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.922*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*60.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*60.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1523*	pc/h/ln
S	*60.0*	mph
D = v_p / S	*25.4*	pc/mi/ln
LOS	*C*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-526 WB
Agency or Company	Atkins	Junction	4170-WB On from Rhett
Date Performed	4/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2013

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Freeway Number of Lanes, N: 2	☐ Yes ☐ On
☑ No ☐ Off	Ramp Number of Lanes, N: 1	☑ No ☐ Off
L_{up} = ft	Acceleration Lane Length, L_A: 625	L_{down} = ft
V_u = veh/h	Deceleration Lane Length L_D:	V_D = veh/h
	Freeway Volume, V_F: 2827	
	Ramp Volume, V_R: 691	
	Freeway Free-Flow Speed, S_{FF}: 60.0	
	Ramp Free-Flow Speed, S_{FR}: 45.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	2827	0.90	Level	10	0	0.952	1.00	3298
Ramp	691	0.90	Level	7	0	0.966	1.00	795
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 1.000 using Equation (Exhibit 13-6)

V_{12} = 3298 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	4093	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	4093	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = 33.1 (pc/mi/ln)

LOS = D (Exhibit 13-2)

Speed Determination

M_S = 0.498 (Exibit 13-11)

S_R= 51.0 mph (Exhibit 13-11)

S_0= N/A mph (Exhibit 13-11)

S = 51.0 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-526 WB
Agency or Company	Atkins	Junction	4170-WB On from Rhett
Date Performed	4/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2013

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Number of Lanes, N: 2	☐ Yes ☐ On
☑ No ☐ Off	Acceleration Lane Length, L_A: 625	☑ No ☐ Off
L_{up} = ft	Deceleration Lane Length L_D:	L_{down} = ft
V_u = veh/h	Freeway Volume, V_F: 2526	V_D = veh/h
	Ramp Volume, V_R: 566	
	Freeway Free-Flow Speed, S_{FF}: 60.0	
	Ramp Free-Flow Speed, S_{FR}: 45.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	2526	0.90	Level	17	0	0.922	1.00	3045
Ramp	566	0.90	Level	9	0	0.957	1.00	657
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 1.000 using Equation (Exhibit 13-6)

V_{12} = 3045 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	3702	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	3702	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = 30.1 (pc/mi/ln)

LOS = D (Exhibit 13-2)

Speed Determination

M_S = 0.423 (Exibit 13-11)

S_R= 52.4 mph (Exhibit 13-11)

S_0= N/A mph (Exhibit 13-11)

S = 52.4 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-526 WB*
Agency or Company	*Atkins*	From/To	*4180-Rhett to Rivers*
Date Performed	*4/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2013*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*3518*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*10*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.952*

Speed Inputs			Calc Speed Adj and FFS		
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f_{LW}		mph
Number of Lanes, N	*2*		f_{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	*55.0*	mph	FFS	*55.0*	mph
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures			Design (N)	
Operational (LOS)			Design (N)	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*2052*	pc/h/ln	Design LOS	
			v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h/ln
S	*53.4*	mph	S	mph
D = v_p / S	*38.4*	pc/mi/ln	D = v_p / S	pc/mi/ln
LOS	*E*		Required Number of Lanes, N	

Glossary		Factor Location	
N - Number of lanes	S - Speed	E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
V - Hourly volume	D - Density	E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 11-18	TRD - Page 11-11
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 11-2, 11-3	
DDHV - Directional design hour volume			

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-526 WB*
Agency or Company	*Atkins*	From/To	*4180-Rhett to Rivers*
Date Performed	*4/25/2014*	Jurisdiction	
Analysis Time Period	*PM Peak*	Analysis Year	*2013*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*3092*	veh/h	Peak-Hour Factor, PHF	*0.90*	
AADT		veh/day	%Trucks and Buses, P_T	*15*	
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*	
Peak-Hr Direction Prop, D			General Terrain:	*Level*	
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*	

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.930*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*55.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*55.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1847*	pc/h/ln
S	*54.9*	mph
D = v_p / S	*33.6*	pc/mi/ln
LOS	*D*	

Design (N)

Design (N)

Design LOS	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h/ln
S	mph
D = v_p / S	pc/mi/ln
Required Number of Lanes, N	

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-526 WB
Agency or Company	Atkins	Junction	4190-WB Off to Rivers NB
Date Performed	3/20/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2013

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Number of Lanes, N: 2	☐ Yes ☐ On
☑ No ☐ Off	Acceleration Lane Length, L_A:	☑ No ☐ Off
L_{up} = ft	Deceleration Lane Length L_D: 725	L_{down} = ft
V_u = veh/h	Freeway Volume, V_F: 3518	V_D = veh/h
	Ramp Volume, V_R: 225	
	Freeway Free-Flow Speed, S_{FF}: 55.0	
	Ramp Free-Flow Speed, S_{FR}: 45.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	3518	0.90	Level	10	0	0.952	1.00	4104
Ramp	225	0.90	Level	3	0	0.985	1.00	254
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 1.000 using Equation (Exhibit 13-7)

V_{12} = 4104 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	4104	Exhibit 13-8	4500	No
$V_{FO} = V_F - V_R$	3850	Exhibit 13-8	4500	No
V_R	254	Exhibit 13-10	2100	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	4104	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = 33.0 (pc/mi/ln)

LOS = D (Exhibit 13-2)

Speed Determination

D_s = 0.321 (Exhibit 13-12)

S_R= 50.8 mph (Exhibit 13-12)

S_0= N/A mph (Exhibit 13-12)

S = 50.8 mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-526 WB
Agency or Company	Atkins	Junction	4190-WB Off to Rivers NB
Date Performed	3/20/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2013

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Number of Lanes, N	2	Downstream Adj Ramp	
☐ Yes	☐ On	Acceleration Lane Length, L_A		☐ Yes	☐ On
☑ No	☐ Off	Deceleration Lane Length L_D	725	☑ No	☐ Off
L_{up} =	ft	Freeway Volume, V_F	3092	L_{down} =	ft
V_u =	veh/h	Ramp Volume, V_R	148	V_D =	veh/h
		Freeway Free-Flow Speed, S_{FF}	55.0		
		Ramp Free-Flow Speed, S_{FR}	45.0		

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	3092	0.90	Level	15	0	0.930	1.00	3693
Ramp	148	0.90	Level	5	0	0.976	1.00	169
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 1.000 using Equation (Exhibit 13-7)

V_{12} = 3693 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	3693	Exhibit 13-8	4500	No
$V_{FO} = V_F - V_R$	3524	Exhibit 13-8	4500	No
V_R	169	Exhibit 13-10	2100	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	3693	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = 29.5 (pc/mi/ln)

LOS = D (Exhibit 13-2)

Speed Determination

D_s = 0.313 (Exhibit 13-12)

S_R= 50.9 mph (Exhibit 13-12)

S_0= N/A mph (Exhibit 13-12)

S = 50.9 mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-526 WB
Agency or Company	Atkins	Junction	4200-WB Off to Rivers SB
Date Performed	3/20/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2013

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Number of Lanes, N	2	Downstream Adj Ramp	
☐ Yes	☐ On	Acceleration Lane Length, L_A		☐ Yes	☐ On
☑ No	☐ Off	Deceleration Lane Length L_D	700	☑ No	☐ Off
L_{up} =	ft	Freeway Volume, V_F	3293	L_{down} =	ft
V_u =	veh/h	Ramp Volume, V_R	201	V_D =	veh/h
		Freeway Free-Flow Speed, S_{FF}	55.0		
		Ramp Free-Flow Speed, S_{FR}	25.0		

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	3293	0.90	Level	10	0	0.952	1.00	3842
Ramp	201	0.90	Level	9	0	0.957	1.00	233
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 1.000 using Equation (Exhibit 13-7)

V_{12} = 3842 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	3842	Exhibit 13-8	4500	No
$V_{FO} = V_F - V_R$	3609	Exhibit 13-8	4500	No
V_R	233	Exhibit 13-10	1900	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	3842	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = 31.0 (pc/mi/ln)

LOS = D (Exhibit 13-2)

Speed Determination

D_s = 0.579 (Exhibit 13-12)

S_R= 47.5 mph (Exhibit 13-12)

S_0= N/A mph (Exhibit 13-12)

S = 47.5 mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-526 WB
Agency or Company	Atkins	Junction	4200-WB Off to Rivers SB
Date Performed	3/20/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2013

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Number of Lanes, N	2	Downstream Adj Ramp	
☐ Yes	☐ On	Acceleration Lane Length, L_A		☐ Yes	☐ On
☑ No	☐ Off	Deceleration Lane Length L_D	700	☑ No	☐ Off
L_{up} =	ft	Freeway Volume, V_F	2944	L_{down} =	ft
V_u =	veh/h	Ramp Volume, V_R	48	V_D =	veh/h
		Freeway Free-Flow Speed, S_{FF}	55.0		
		Ramp Free-Flow Speed, S_{FR}	25.0		

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	2944	0.90	Level	16	0	0.926	1.00	3533
Ramp	48	0.90	Level	13	0	0.939	1.00	57
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 1.000 using Equation (Exhibit 13-7)

V_{12} = 3533 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	3533	Exhibit 13-8	4500	No
$V_{FO} = V_F - V_R$	3476	Exhibit 13-8	4500	No
V_R	57	Exhibit 13-10	1900	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	3533	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = 28.3 (pc/mi/ln)

LOS = D (Exhibit 13-2)

Speed Determination

D_s = 0.563 (Exhibit 13-12)

S_R= 47.7 mph (Exhibit 13-12)

S_0= N/A mph (Exhibit 13-12)

S = 47.7 mph (Exhibit 13-13)

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-526 WB*
Agency or Company	*Atkins*	From/To	*4205-RiversSB Off to Rivers On*
Date Performed	*4/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2013*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*3092*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*10*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.952*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*55.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*55.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1804*	pc/h/ln
S	*55.0*	mph
D = v_p / S	*32.8*	pc/mi/ln
LOS	*D*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-526 WB*
Agency or Company	*Atkins*	From/To	*4205-RiversSB Off to Rivers On*
Date Performed	*4/25/2014*	Jurisdiction	
Analysis Time Period	*PM Peak*	Analysis Year	*2013*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*2896*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*16*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.926*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*55.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*55.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1738*	pc/h/ln
S	*55.0*	mph
D = v_p / S	*31.6*	pc/mi/ln
LOS	*D*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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Navy Base ICTF

FREEWAY WEAVING WORKSHEET

General Information

Analyst	AJR
Agency/Company	Atkins
Date Performed	3/20/2014
Analysis Time Period	AM Peak

Site Information

Freeway/Dir of Travel	I-526 WB
Weaving Segment Location	4210 - Rivers to I-26 WB
Analysis Year	2013

Project Description *Navy Base ICTF*

Inputs

Weaving configuration	One-Sided	Segment type	Freeway
Weaving number of lanes, N	3	Freeway minimum speed, S_{MIN}	15
Weaving segment length, L_S	725ft	Freeway maximum capacity, C_{IFL}	2250
Freeway free-flow speed, FFS	55 mph	Terrain type	Level

Conversions to pc/h Under Base Conditions

	V (veh/h)	PHF	Truck (%)	RV (%)	E_T	E_R	f_{HV}	f_p	v (pc/h)
V_{FF}	2078	0.90	4	0	1.5	1.2	0.980	1.00	2355
V_{RF}	347	0.90	3	0	1.5	1.2	0.985	1.00	391
V_{FR}	1014	0.90	23	0	1.5	1.2	0.897	1.00	1256
V_{RR}	170	0.90	16	0	1.5	1.2	0.926	1.00	204
V_{NW}	2559							V =	4206
V_W	1647								
VR	0.392								

Configuration Characteristics

Minimum maneuver lanes, N_{WL}	2 lc	Minimum weaving lane changes, LC_{MIN}	1647 lc/h
Interchange density, ID	1.2 int/mi	Weaving lane changes, LC_W	1783 lc/h
Minimum RF lane changes, LC_{RF}	1 lc/pc	Non-weaving lane changes, LC_{NW}	342 lc/h
Minimum FR lane changes, LC_{FR}	1 lc/pc	Total lane changes, LC_{ALL}	2125 lc/h
Minimum RR lane changes, LC_{RR}	lc/pc	Non-weaving vehicle index, I_{NW}	223

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment flow rate, v	4206 pc/h	Weaving intensity factor, W	0.528
Weaving segment capacity, c_w	5300 veh/h	Weaving segment speed, S	38.1 mph
Weaving segment v/c ratio	0.778	Average weaving speed, S_W	41.2 mph
Weaving segment density, D	36.8 pc/mi/ln	Average non-weaving speed, S_{NW}	36.4 mph
Level of Service, LOS	E	Maximum weaving length, L_{MAX}	6587 ft

Notes

a. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments".
b. For volumes that exceed the weaving segment capacity, the level of service is "F".

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Navy Base ICTF

FREEWAY WEAVING WORKSHEET

General Information

Analyst	AJR
Agency/Company	Atkins
Date Performed	3/20/2014
Analysis Time Period	PM Peak

Site Information

Freeway/Dir of Travel	I-526 WB
Weaving Segment Location	4210 - Rivers to I-26 WB
Analysis Year	2013

Project Description *Navy Base ICTF*

Inputs

Weaving configuration	One-Sided	Segment type	Freeway
Weaving number of lanes, N	3	Freeway minimum speed, S_{MIN}	15
Weaving segment length, L_S	725ft	Freeway maximum capacity, C_{IFL}	2250
Freeway free-flow speed, FFS	55 mph	Terrain type	Level

Conversions to pc/h Under Base Conditions

	V (veh/h)	PHF	Truck (%)	RV (%)	E_T	E_R	f_{HV}	f_p	v (pc/h)
V_{FF}	1675	0.90	6	0	1.5	1.2	0.971	1.00	1917
V_{RF}	282	0.90	2	0	1.5	1.2	0.990	1.00	316
V_{FR}	1221	0.90	30	0	1.5	1.2	0.870	1.00	1560
V_{RR}	205	0.90	3	0	1.5	1.2	0.985	1.00	231
V_{NW}	2148							V =	4024
V_W	1876								
VR	0.466								

Configuration Characteristics

Minimum maneuver lanes, N_{WL}	2 lc	Minimum weaving lane changes, LC_{MIN}	1876 lc/h
Interchange density, ID	1.2 int/mi	Weaving lane changes, LC_W	2012 lc/h
Minimum RF lane changes, LC_{RF}	1 lc/pc	Non-weaving lane changes, LC_{NW}	258 lc/h
Minimum FR lane changes, LC_{FR}	1 lc/pc	Total lane changes, LC_{ALL}	2270 lc/h
Minimum RR lane changes, LC_{RR}	lc/pc	Non-weaving vehicle index, I_{NW}	187

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment flow rate, v	4024 pc/h	Weaving intensity factor, W	0.556
Weaving segment capacity, c_w	4998 veh/h	Weaving segment speed, S	37.5 mph
Weaving segment v/c ratio	0.782	Average weaving speed, S_W	40.7 mph
Weaving segment density, D	35.8 pc/mi/ln	Average non-weaving speed, S_{NW}	35.1 mph
Level of Service, LOS	E	Maximum weaving length, L_{MAX}	7434 ft

Notes

a. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments".
b. For volumes that exceed the weaving segment capacity, the level of service is "F".

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-526 WB*
Agency or Company	*Atkins*	From/To	*4215-I-26 WB Off to I-26 WB On*
Date Performed	*4/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2013*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*2425*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*4*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.980*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*55.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*55.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1374*	pc/h/ln
S	*55.0*	mph
D = v_p / S	*25.0*	pc/mi/ln
LOS	*C*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-526 WB*
Agency or Company	*Atkins*	From/To	*4215-I-26 WB Off to I-26 WB On*
Date Performed	*4/25/2014*	Jurisdiction	
Analysis Time Period	*PM Peak*	Analysis Year	*2013*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*1957*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*5*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length	*mi*
			Up/Down %	

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.976*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*55.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*55.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1114*	pc/h/ln
S	*55.0*	mph
D = v_p / S	*20.3*	pc/mi/ln
LOS	*C*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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Navy Base ICTF

FREEWAY WEAVING WORKSHEET

General Information

Analyst	AJR
Agency/Company	Atkins
Date Performed	3/20/2014
Analysis Time Period	AM Peak

Site Information

Freeway/Dir of Travel	I-526 WB
Weaving Segment Location	4220 - I-26 WB to I-26 EB C-D
Analysis Year	2013

Project Description *Navy Base ICTF*

Inputs

Weaving configuration	One-Sided	Segment type	Freeway
Weaving number of lanes, N	3	Freeway minimum speed, S_{MIN}	15
Weaving segment length, L_S	550ft	Freeway maximum capacity, C_{IFL}	2250
Freeway free-flow speed, FFS	55 mph	Terrain type	Level

Conversions to pc/h Under Base Conditions

	V (veh/h)	PHF	Truck (%)	RV (%)	E_T	E_R	f_{HV}	f_p	v (pc/h)
V_{FF}	1905	0.90	2	0	1.5	1.2	0.990	1.00	2138
V_{RF}	267	0.90	7	0	1.5	1.2	0.966	1.00	307
V_{FR}	520	0.90	15	0	1.5	1.2	0.930	1.00	621
V_{RR}	0	0.90	0	0	1.5	1.2	1.000	1.00	0
V_{NW}	2138							V =	3066
V_W	928								
VR	0.303								

Configuration Characteristics

Minimum maneuver lanes, N_{WL}	2 lc	Minimum weaving lane changes, LC_{MIN}	928 lc/h
Interchange density, ID	1.2 int/mi	Weaving lane changes, LC_W	1032 lc/h
Minimum RF lane changes, LC_{RF}	1 lc/pc	Non-weaving lane changes, LC_{NW}	161 lc/h
Minimum FR lane changes, LC_{FR}	1 lc/pc	Total lane changes, LC_{ALL}	1193 lc/h
Minimum RR lane changes, LC_{RR}	lc/pc	Non-weaving vehicle index, I_{NW}	141

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment flow rate, v	3066 pc/h	Weaving intensity factor, W	0.416
Weaving segment capacity, c_w	5534 veh/h	Weaving segment speed, S	43.4 mph
Weaving segment v/c ratio	0.549	Average weaving speed, S_W	43.2 mph
Weaving segment density, D	23.6 pc/mi/ln	Average non-weaving speed, S_{NW}	43.4 mph
Level of Service, LOS	C	Maximum weaving length, L_{MAX}	5613 ft

Notes

a. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments".
b. For volumes that exceed the weaving segment capacity, the level of service is "F".

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Navy Base ICTF

FREEWAY WEAVING WORKSHEET

General Information

Analyst	AJR
Agency/Company	Atkins
Date Performed	3/20/2014
Analysis Time Period	PM Peak

Site Information

Freeway/Dir of Travel	I-526 WB
Weaving Segment Location	4220 - I-26 WB to I-26 EB C-D
Analysis Year	2013

Project Description *Navy Base ICTF*

Inputs

Weaving configuration	One-Sided	Segment type	Freeway
Weaving number of lanes, N	3	Freeway minimum speed, S_{MIN}	15
Weaving segment length, L_S	550ft	Freeway maximum capacity, C_{IFL}	2250
Freeway free-flow speed, FFS	55 mph	Terrain type	Level

Conversions to pc/h Under Base Conditions

	V (veh/h)	PHF	Truck (%)	RV (%)	E_T	E_R	f_{HV}	f_p	v (pc/h)
V_{FF}	1499	0.90	3	0	1.5	1.2	0.985	1.00	1691
V_{RF}	328	0.90	5	0	1.5	1.2	0.976	1.00	374
V_{FR}	458	0.90	14	0	1.5	1.2	0.935	1.00	545
V_{RR}	0	0.90	0	0	1.5	1.2	1.000	1.00	0
V_{NW}	1691							V =	2610
V_W	919								
VR	0.352								

Configuration Characteristics

Minimum maneuver lanes, N_{WL}	2 lc	Minimum weaving lane changes, LC_{MIN}	919 lc/h
Interchange density, ID	1.2 int/mi	Weaving lane changes, LC_W	1023 lc/h
Minimum RF lane changes, LC_{RF}	1 lc/pc	Non-weaving lane changes, LC_{NW}	69 lc/h
Minimum FR lane changes, LC_{FR}	1 lc/pc	Total lane changes, LC_{ALL}	1092 lc/h
Minimum RR lane changes, LC_{RR}	lc/pc	Non-weaving vehicle index, I_{NW}	112

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment flow rate, v	2610 pc/h	Weaving intensity factor, W	0.388
Weaving segment capacity, c_w	5385 veh/h	Weaving segment speed, S	44.1 mph
Weaving segment v/c ratio	0.478	Average weaving speed, S_W	43.8 mph
Weaving segment density, D	19.7 pc/mi/ln	Average non-weaving speed, S_{NW}	44.2 mph
Level of Service, LOS	B	Maximum weaving length, L_{MAX}	6150 ft

Notes

a. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments".
b. For volumes that exceed the weaving segment capacity, the level of service is "F".

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-526 WB*
Agency or Company	*Atkins*	From/To	*4225-I-26 EB CD Off to On*
Date Performed	*4/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2013*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*2172*	veh/h	Peak-Hour Factor, PHF	*0.90*	
AADT		veh/day	%Trucks and Buses, P_T	*2*	
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*	
Peak-Hr Direction Prop, D			General Terrain:	*Level*	
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*	

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.990*

Speed Inputs			Calc Speed Adj and FFS		
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f_{LW}		mph
Number of Lanes, N	*2*		f_{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	*55.0*	mph	FFS	*55.0*	mph
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures			Design (N)	
Operational (LOS)			Design (N)	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1219*	pc/h/ln	Design LOS	
S	*55.0*	mph	v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h/ln
D = v_p / S	*22.2*	pc/mi/ln	S	mph
LOS	*C*		D = v_p / S	pc/mi/ln
			Required Number of Lanes, N	

Glossary		Factor Location	
N - Number of lanes	S - Speed	E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
V - Hourly volume	D - Density	E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 11-18	TRD - Page 11-11
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 11-2, 11-3	
DDHV - Directional design hour volume			

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F-2443

BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-526 WB*
Agency or Company	*Atkins*	From/To	*4225-I-26 EB CD Off to On*
Date Performed	*4/25/2014*	Jurisdiction	
Analysis Time Period	*PM Peak*	Analysis Year	*2013*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*1827*	veh/h	Peak-Hour Factor, PHF	*0.90*	
AADT		veh/day	%Trucks and Buses, P_T	*3*	
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*	
Peak-Hr Direction Prop, D			General Terrain:	*Level*	
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*	

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.985*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*55.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*55.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1030*	pc/h/ln
S	*55.0*	mph
D = v_p / S	*18.7*	pc/mi/ln
LOS	*C*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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Navy Base ICTF

FREEWAY WEAVING WORKSHEET

General Information

Analyst	AJR
Agency/Company	Atkins
Date Performed	3/20/2014
Analysis Time Period	AM Peak

Site Information

Freeway/Dir of Travel	I-526 WB
Weaving Segment Location	4230-I-26EBCD to International
Analysis Year	2013

Project Description *Navy Base ICTF*

Inputs

Weaving configuration	One-Sided	Segment type	Freeway
Weaving number of lanes, N	3	Freeway minimum speed, S_{MIN}	15
Weaving segment length, L_S	3135ft	Freeway maximum capacity, C_{IFL}	2300
Freeway free-flow speed, FFS	60 mph	Terrain type	Level

Conversions to pc/h Under Base Conditions

	V (veh/h)	PHF	Truck (%)	RV (%)	E_T	E_R	f_{HV}	f_p	v (pc/h)
V_{FF}	1607	0.90	2	0	1.5	1.2	0.990	1.00	1803
V_{RF}	1431	0.90	13	0	1.5	1.2	0.939	1.00	1693
V_{FR}	565	0.90	2	0	1.5	1.2	0.990	1.00	634
V_{RR}	503	0.90	20	0	1.5	1.2	0.909	1.00	615
V_{NW}	2418							V =	4745
V_W	2327								
VR	0.490								

Configuration Characteristics

Minimum maneuver lanes, N_{WL}	2 lc	Minimum weaving lane changes, LC_{MIN}	2327 lc/h
Interchange density, ID	1.0 int/mi	Weaving lane changes, LC_W	2652 lc/h
Minimum RF lane changes, LC_{RF}	1 lc/pc	Non-weaving lane changes, LC_{NW}	1619 lc/h
Minimum FR lane changes, LC_{FR}	1 lc/pc	Total lane changes, LC_{ALL}	4271 lc/h
Minimum RR lane changes, LC_{RR}	lc/pc	Non-weaving vehicle index, I_{NW}	758

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment flow rate, v	4745 pc/h	Weaving intensity factor, W	0.288
Weaving segment capacity, c_w	4845 veh/h	Weaving segment speed, S	41.5 mph
Weaving segment v/c ratio	0.970	Average weaving speed, S_W	49.9 mph
Weaving segment density, D	38.1 pc/mi/ln	Average non-weaving speed, S_{NW}	35.7 mph
Level of Service, LOS	E	Maximum weaving length, L_{MAX}	7715 ft

Notes

a. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments".
b. For volumes that exceed the weaving segment capacity, the level of service is "F".

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Navy Base ICTF

FREEWAY WEAVING WORKSHEET

General Information

Analyst	AJR
Agency/Company	Atkins
Date Performed	3/20/2014
Analysis Time Period	PM Peak

Site Information

Freeway/Dir of Travel	I-526 WB
Weaving Segment Location	4230-I-26EBCD to International
Analysis Year	2013

Project Description *Navy Base ICTF*

Inputs

Weaving configuration	One-Sided	Segment type	Freeway
Weaving number of lanes, N	3	Freeway minimum speed, S_{MIN}	15
Weaving segment length, L_S	3135ft	Freeway maximum capacity, C_{IFL}	2300
Freeway free-flow speed, FFS	60 mph	Terrain type	Level

Conversions to pc/h Under Base Conditions

	V (veh/h)	PHF	Truck (%)	RV (%)	E_T	E_R	f_{HV}	f_p	v (pc/h)
V_{FF}	1170	0.90	3	0	1.5	1.2	0.985	1.00	1320
V_{RF}	994	0.90	21	0	1.5	1.2	0.905	1.00	1220
V_{FR}	657	0.90	2	0	1.5	1.2	0.990	1.00	737
V_{RR}	557	0.90	14	0	1.5	1.2	0.935	1.00	662
V_{NW}	1982							V =	3939
V_W	1957								
VR	0.497								

Configuration Characteristics

Minimum maneuver lanes, N_{WL}	2 lc	Minimum weaving lane changes, LC_{MIN}	1957 lc/h
Interchange density, ID	1.0 int/mi	Weaving lane changes, LC_W	2282 lc/h
Minimum RF lane changes, LC_{RF}	1 lc/pc	Non-weaving lane changes, LC_{NW}	1530 lc/h
Minimum FR lane changes, LC_{FR}	1 lc/pc	Total lane changes, LC_{ALL}	3812 lc/h
Minimum RR lane changes, LC_{RR}	lc/pc	Non-weaving vehicle index, I_{NW}	621

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment flow rate, v	3939 pc/h	Weaving intensity factor, W	0.264
Weaving segment capacity, c_w	4759 veh/h	Weaving segment speed, S	44.4 mph
Weaving segment v/c ratio	0.815	Average weaving speed, S_W	50.6 mph
Weaving segment density, D	29.6 pc/mi/ln	Average non-weaving speed, S_{NW}	39.6 mph
Level of Service, LOS	D	Maximum weaving length, L_{MAX}	7789 ft

Notes

a. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments".
b. For volumes that exceed the weaving segment capacity, the level of service is "F".

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-526 WB*
Agency or Company	*Atkins*	From/To	*4235-Interna Off to Interna On*
Date Performed	*4/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2013*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs				
Volume, V	*3038*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*7*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.966*

Speed Inputs			Calc Speed Adj and FFS		
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f_{LW}		mph
Number of Lanes, N	*2*		f_{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	*60.0*	mph	FFS	*60.0*	mph
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures			Design (N)	
Operational (LOS)			Design (N)	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1747*	pc/h/ln	Design LOS	
S	*59.6*	mph	v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h/ln
D = v_p / S	*29.3*	pc/mi/ln	S	mph
LOS	*D*		D = v_p / S	pc/mi/ln
			Required Number of Lanes, N	

Glossary		Factor Location	
N - Number of lanes	S - Speed	E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
V - Hourly volume	D - Density	E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 11-18	TRD - Page 11-11
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 11-2, 11-3	
DDHV - Directional design hour volume			

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-526 WB*
Agency or Company	*Atkins*	From/To	*4235-Interna Off to Interna On*
Date Performed	*4/25/2014*	Jurisdiction	
Analysis Time Period	*PM Peak*	Analysis Year	*2013*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*2164*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*12*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.943*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*60.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*60.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1274*	pc/h/ln
S	*60.0*	mph
D = v_p / S	*21.2*	pc/mi/ln
LOS	*C*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-526 WB
Agency or Company	Atkins	Junction	4240-WB On from International
Date Performed	4/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2013

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Number of Lanes, N: 2	☐ Yes ☐ On
☑ No ☐ Off	Acceleration Lane Length, L_A: 875	☑ No ☐ Off
L_{up} = ft	Deceleration Lane Length L_D:	L_{down} = ft
V_u = veh/h	Freeway Volume, V_F: 3038	V_D = veh/h
	Ramp Volume, V_R: 363	
	Freeway Free-Flow Speed, S_{FF}: 60.0	
	Ramp Free-Flow Speed, S_{FR}: 45.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	3038	0.90	Level	7	0	0.966	1.00	3494
Ramp	363	0.90	Level	12	0	0.943	1.00	428
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 1.000 using Equation (Exhibit 13-6)

V_{12} = 3494 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	3922	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	3922	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = 30.4 (pc/mi/ln)

LOS = D (Exhibit 13-2)

Speed Determination

M_S = 0.439 (Exibit 13-11)

S_R= 52.1 mph (Exhibit 13-11)

S_0= N/A mph (Exhibit 13-11)

S = 52.1 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-526 WB
Agency or Company	Atkins	Junction	4240-WB On from International
Date Performed	4/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2013

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Number of Lanes, N: 2	☐ Yes ☐ On
☑ No ☐ Off	Acceleration Lane Length, L_A: 875	☑ No ☐ Off
L_{up} = ft	Deceleration Lane Length L_D:	L_{down} = ft
V_u = veh/h	Freeway Volume, V_F: 2164	V_D = veh/h
	Ramp Volume, V_R: 542	
	Freeway Free-Flow Speed, S_{FF}: 60.0	
	Ramp Free-Flow Speed, S_{FR}: 45.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	2164	0.90	Level	12	0	0.943	1.00	2549
Ramp	542	0.90	Level	13	0	0.939	1.00	641
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 1.000 using Equation (Exhibit 13-6)

V_{12} = 2549 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	3190	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	3190	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = 24.6 (pc/mi/ln)

LOS = C (Exhibit 13-2)

Speed Determination

M_S = 0.337 (Exibit 13-11)

S_R= 53.9 mph (Exhibit 13-11)

S_0= N/A mph (Exhibit 13-11)

S = 53.9 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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Navy Base ICTF

FREEWAY WEAVING WORKSHEET

General Information

Analyst	AJR
Agency/Company	Atkins
Date Performed	3/20/2014
Analysis Time Period	AM Peak

Site Information

Freeway/Dir of Travel	I-526 WB
Weaving Segment Location	4250-Montague to Dorchester
Analysis Year	2013

Project Description *Navy Base ICTF*

Inputs

Weaving configuration	One-Sided	Segment type	Freeway
Weaving number of lanes, N	3	Freeway minimum speed, S_{MIN}	15
Weaving segment length, L_S	950ft	Freeway maximum capacity, C_{IFL}	2300
Freeway free-flow speed, FFS	60 mph	Terrain type	Level

Conversions to pc/h Under Base Conditions

	V (veh/h)	PHF	Truck (%)	RV (%)	E_T	E_R	f_{HV}	f_p	v (pc/h)
V_{FF}	2706	0.90	6	0	1.5	1.2	0.971	1.00	3097
V_{RF}	222	0.90	9	0	1.5	1.2	0.957	1.00	258
V_{FR}	695	0.90	12	0	1.5	1.2	0.943	1.00	819
V_{RR}	57	0.90	16	0	1.5	1.2	0.926	1.00	68
V_{NW}	3165							V =	4242
V_W	1077								
VR	0.254								

Configuration Characteristics

Minimum maneuver lanes, N_{WL}	2 lc	Minimum weaving lane changes, LC_{MIN}	1077 lc/h
Interchange density, ID	1.0 int/mi	Weaving lane changes, LC_W	1233 lc/h
Minimum RF lane changes, LC_{RF}	1 lc/pc	Non-weaving lane changes, LC_{NW}	589 lc/h
Minimum FR lane changes, LC_{FR}	1 lc/pc	Total lane changes, LC_{ALL}	1822 lc/h
Minimum RR lane changes, LC_{RR}	lc/pc	Non-weaving vehicle index, I_{NW}	301

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment flow rate, v	4242 pc/h	Weaving intensity factor, W	0.378
Weaving segment capacity, c_w	5776 veh/h	Weaving segment speed, S	46.0 mph
Weaving segment v/c ratio	0.713	Average weaving speed, S_W	47.7 mph
Weaving segment density, D	30.7 pc/mi/ln	Average non-weaving speed, S_{NW}	45.5 mph
Level of Service, LOS	D	Maximum weaving length, L_{MAX}	5095 ft

Notes

a. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments".
b. For volumes that exceed the weaving segment capacity, the level of service is "F".

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Navy Base ICTF

FREEWAY WEAVING WORKSHEET

General Information

Analyst	AJR
Agency/Company	Atkins
Date Performed	3/20/2014
Analysis Time Period	PM Peak

Site Information

Freeway/Dir of Travel	I-526 WB
Weaving Segment Location	4250-Montague to Dorchester
Analysis Year	2013

Project Description *Navy Base ICTF*

Inputs

Weaving configuration	One-Sided
Weaving number of lanes, N	3
Weaving segment length, L_S	950ft
Freeway free-flow speed, FFS	60 mph
Segment type	Freeway
Freeway minimum speed, S_{MIN}	15
Freeway maximum capacity, C_{IFL}	2300
Terrain type	Level

Conversions to pc/h Under Base Conditions

	V (veh/h)	PHF	Truck (%)	RV (%)	E_T	E_R	f_{HV}	f_p	v (pc/h)
V_{FF}	2192	0.90	9	0	1.5	1.2	0.957	1.00	2545
V_{RF}	305	0.90	6	0	1.5	1.2	0.971	1.00	349
V_{FR}	514	0.90	22	0	1.5	1.2	0.901	1.00	634
V_{RR}	72	0.90	14	0	1.5	1.2	0.935	1.00	86
V_{NW}	2631							V =	3614
V_W	983								
VR	0.272								

Configuration Characteristics

Minimum maneuver lanes, N_{WL}	2 lc	Minimum weaving lane changes, LC_{MIN}	983 lc/h
Interchange density, ID	1.0 int/mi	Weaving lane changes, LC_W	1139 lc/h
Minimum RF lane changes, LC_{RF}	1 lc/pc	Non-weaving lane changes, LC_{NW}	479 lc/h
Minimum FR lane changes, LC_{FR}	1 lc/pc	Total lane changes, LC_{ALL}	1618 lc/h
Minimum RR lane changes, LC_{RR}	lc/pc	Non-weaving vehicle index, I_{NW}	250

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment flow rate, v	3614 pc/h	Weaving intensity factor, W	0.344
Weaving segment capacity, c_w	5650 veh/h	Weaving segment speed, S	47.5 mph
Weaving segment v/c ratio	0.612	Average weaving speed, S_W	48.5 mph
Weaving segment density, D	25.4 pc/mi/ln	Average non-weaving speed, S_{NW}	47.1 mph
Level of Service, LOS	C	Maximum weaving length, L_{MAX}	5285 ft

Notes

a. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments".
b. For volumes that exceed the weaving segment capacity, the level of service is "F".

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-526 WB*
Agency or Company	*Atkins*	From/To	*4255-Dorches Off to Dorches On*
Date Performed	*4/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2013*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*2928*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*6*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.971*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*60.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*60.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1675*	pc/h/ln
S	*59.9*	mph
D = v_p / S	*28.0*	pc/mi/ln
LOS	*D*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-526 WB*
Agency or Company	*Atkins*	From/To	*4255-Dorches Off to Dorches On*
Date Performed	*4/25/2014*	Jurisdiction	
Analysis Time Period	*PM Peak*	Analysis Year	*2013*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*2497*	veh/h	Peak-Hour Factor, PHF	*0.90*	
AADT		veh/day	%Trucks and Buses, P_T	*9*	
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*	
Peak-Hr Direction Prop, D			General Terrain:	*Level*	
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*	

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.957*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*60.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*60.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1450*	pc/h/ln
S	*60.0*	mph
D = v_p / S	*24.2*	pc/mi/ln
LOS	*C*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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Navy Base ICTF

FREEWAY WEAVING WORKSHEET

General Information

Analyst	AJR
Agency/Company	Atkins
Date Performed	3/20/2014
Analysis Time Period	AM Peak

Site Information

Freeway/Dir of Travel	I-526 WB
Weaving Segment Location	4260-Dorchester to Leeds
Analysis Year	2013

Project Description *Navy Base ICTF*

Inputs

Weaving configuration	One-Sided	Segment type	Freeway
Weaving number of lanes, N	3	Freeway minimum speed, S_{MIN}	15
Weaving segment length, L_S	1750ft	Freeway maximum capacity, C_{IFL}	2300
Freeway free-flow speed, FFS	60 mph	Terrain type	Level

Conversions to pc/h Under Base Conditions

	V (veh/h)	PHF	Truck (%)	RV (%)	E_T	E_R	f_{HV}	f_p	v (pc/h)
V_{FF}	2107	0.90	8	0	1.5	1.2	0.962	1.00	2435
V_{RF}	440	0.90	21	0	1.5	1.2	0.905	1.00	540
V_{FR}	821	0.90	2	0	1.5	1.2	0.990	1.00	921
V_{RR}	171	0.90	7	0	1.5	1.2	0.966	1.00	197
V_{NW}	2632							V =	4093
V_W	1461								
VR	0.357								

Configuration Characteristics

Minimum maneuver lanes, N_{WL}	2 lc	Minimum weaving lane changes, LC_{MIN}	1461 lc/h
Interchange density, ID	1.0 int/mi	Weaving lane changes, LC_W	1694 lc/h
Minimum RF lane changes, LC_{RF}	1 lc/pc	Non-weaving lane changes, LC_{NW}	913 lc/h
Minimum FR lane changes, LC_{FR}	1 lc/pc	Total lane changes, LC_{ALL}	2607 lc/h
Minimum RR lane changes, LC_{RR}	lc/pc	Non-weaving vehicle index, I_{NW}	461

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment flow rate, v	4093 pc/h	Weaving intensity factor, W	0.310
Weaving segment capacity, c_w	5651 veh/h	Weaving segment speed, S	45.0 mph
Weaving segment v/c ratio	0.696	Average weaving speed, S_W	49.4 mph
Weaving segment density, D	30.3 pc/mi/ln	Average non-weaving speed, S_{NW}	42.9 mph
Level of Service, LOS	D	Maximum weaving length, L_{MAX}	6203 ft

Notes

a. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments".
b. For volumes that exceed the weaving segment capacity, the level of service is "F".

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Navy Base ICTF

FREEWAY WEAVING WORKSHEET

General Information

Analyst	AJR
Agency/Company	Atkins
Date Performed	3/20/2014
Analysis Time Period	PM Peak

Site Information

Freeway/Dir of Travel	I-526 WB
Weaving Segment Location	4260-Dorchester to Leeds
Analysis Year	2013

Project Description *Navy Base ICTF*

Inputs

Weaving configuration	One-Sided	Segment type	Freeway
Weaving number of lanes, N	3	Freeway minimum speed, S_{MIN}	15
Weaving segment length, L_S	1750ft	Freeway maximum capacity, C_{IFL}	2300
Freeway free-flow speed, FFS	60 mph	Terrain type	Level

Conversions to pc/h Under Base Conditions

	V (veh/h)	PHF	Truck (%)	RV (%)	E_T	E_R	f_{HV}	f_p	v (pc/h)
V_{FF}	2244	0.90	9	0	1.5	1.2	0.957	1.00	2606
V_{RF}	466	0.90	21	0	1.5	1.2	0.905	1.00	572
V_{FR}	253	0.90	4	0	1.5	1.2	0.980	1.00	287
V_{RR}	53	0.90	8	0	1.5	1.2	0.962	1.00	61
V_{NW}	2667							V =	3526
V_W	859								
VR	0.244								

Configuration Characteristics

Minimum maneuver lanes, N_{WL}	2 lc	Minimum weaving lane changes, LC_{MIN}	859 lc/h
Interchange density, ID	1.0 int/mi	Weaving lane changes, LC_W	1092 lc/h
Minimum RF lane changes, LC_{RF}	1 lc/pc	Non-weaving lane changes, LC_{NW}	920 lc/h
Minimum FR lane changes, LC_{FR}	1 lc/pc	Total lane changes, LC_{ALL}	2012 lc/h
Minimum RR lane changes, LC_{RR}	lc/pc	Non-weaving vehicle index, I_{NW}	467

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment flow rate, v	3526 pc/h	Weaving intensity factor, W	0.252
Weaving segment capacity, c_w	5891 veh/h	Weaving segment speed, S	48.8 mph
Weaving segment v/c ratio	0.573	Average weaving speed, S_W	50.9 mph
Weaving segment density, D	24.1 pc/mi/ln	Average non-weaving speed, S_{NW}	48.2 mph
Level of Service, LOS	C	Maximum weaving length, L_{MAX}	4987 ft

Notes

a. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments".
b. For volumes that exceed the weaving segment capacity, the level of service is "F".

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-526 WB*
Agency or Company	*Atkins*	From/To	*4265-Leeds Off to Leeds On*
Date Performed	*4/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2013*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*2547*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*10*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.952*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*60.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*60.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1486*	pc/h/ln
S	*60.0*	mph
D = v_p / S	*24.8*	pc/mi/ln
LOS	*C*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-526 WB*
Agency or Company	*Atkins*	From/To	*4265-Leeds Off to Leeds On*
Date Performed	*4/25/2014*	Jurisdiction	
Analysis Time Period	*PM Peak*	Analysis Year	*2013*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*2710*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*12*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.943*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*60.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*60.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1596*	pc/h/ln
S	*60.0*	mph
D = v_p / S	*26.6*	pc/mi/ln
LOS	*D*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-526 WB
Agency or Company	Atkins	Junction	4270-WB On from Leeds
Date Performed	4/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2013

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Number of Lanes, N: 2	☐ Yes ☐ On
☑ No ☐ Off	Acceleration Lane Length, L_A: 825	☑ No ☐ Off
L_{up} = ft	Deceleration Lane Length L_D:	L_{down} = ft
V_u = veh/h	Freeway Volume, V_F: 2547	V_D = veh/h
	Ramp Volume, V_R: 214	
	Freeway Free-Flow Speed, S_{FF}: 60.0	
	Ramp Free-Flow Speed, S_{FR}: 45.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	2547	0.90	Level	10	0	0.952	1.00	2972
Ramp	214	0.90	Level	32	0	0.862	1.00	276
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 1.000 using Equation (Exhibit 13-6)

V_{12} = 2972 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	3248	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	3248	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = 25.5 (pc/mi/ln)

LOS = C (Exhibit 13-2)

Speed Determination

M_S = 0.347 (Exibit 13-11)

S_R= 53.8 mph (Exhibit 13-11)

S_0= N/A mph (Exhibit 13-11)

S = 53.8 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-526 WB
Agency or Company	Atkins	Junction	4270-WB On from Leeds
Date Performed	4/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2013

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Number of Lanes, N: 2	☐ Yes ☐ On
☑ No ☐ Off	Acceleration Lane Length, L_A: 825	☑ No ☐ Off
L_{up} = ft	Deceleration Lane Length L_D:	L_{down} = ft
V_u = veh/h	Freeway Volume, V_F: 2710	V_D = veh/h
	Ramp Volume, V_R: 670	
	Freeway Free-Flow Speed, S_{FF}: 60.0	
	Ramp Free-Flow Speed, S_{FR}: 45.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	2710	0.90	Level	12	0	0.943	1.00	3192
Ramp	670	0.90	Level	4	0	0.980	1.00	759
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 1.000 using Equation (Exhibit 13-6)

V_{12} = 3192 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	3951	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	3951	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = 30.8 (pc/mi/ln)

LOS = D (Exhibit 13-2)

Speed Determination

M_S = 0.450 (Exibit 13-11)

S_R= 51.9 mph (Exhibit 13-11)

S_0= N/A mph (Exhibit 13-11)

S = 51.9 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-526 WB*
Agency or Company	*Atkins*	From/To	*4280-Leeds to Paul Cantrell*
Date Performed	*4/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2013*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*2761*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*12*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.943*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*60.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*60.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1626*	pc/h/ln
S	*60.0*	mph
D = v_p / S	*27.1*	pc/mi/ln
LOS	*D*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-526 WB*
Agency or Company	*Atkins*	From/To	*4280-Leeds to Paul Cantrell*
Date Performed	*4/25/2014*	Jurisdiction	
Analysis Time Period	*PM Peak*	Analysis Year	*2013*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*3380*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*10*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.952*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*60.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*60.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1972*	pc/h/ln
S	*57.5*	mph
D = v_p / S	*34.3*	pc/mi/ln
LOS	*D*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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F-2462

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-526 WB
Agency or Company	Atkins	Junction	4290-WB Off to PaulCantrell WB
Date Performed	3/20/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2013

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Number of Lanes, N	2	Downstream Adj Ramp	
☐ Yes	☐ On	Acceleration Lane Length, L_A		☐ Yes	☐ On
☑ No	☐ Off	Deceleration Lane Length L_D	825	☑ No	☐ Off
L_{up} =	ft	Freeway Volume, V_F	2761	L_{down} =	ft
V_u =	veh/h	Ramp Volume, V_R	1033	V_D =	veh/h
		Freeway Free-Flow Speed, S_{FF}	60.0		
		Ramp Free-Flow Speed, S_{FR}	45.0		

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	2761	0.90	Level	12	0	0.943	1.00	3252
Ramp	1033	0.90	Level	21	0	0.905	1.00	1268
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 1.000 using Equation (Exhibit 13-7)

V_{12} = 3252 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	3252	Exhibit 13-8	4600	No
$V_{FO} = V_F - V_R$	1984	Exhibit 13-8	4600	No
V_R	1268	Exhibit 13-10	2100	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	3252	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = 24.8 (pc/mi/ln)

LOS = C (Exhibit 13-2)

Speed Determination

D_s = 0.412 (Exhibit 13-12)

S_R= 52.6 mph (Exhibit 13-12)

S_0= N/A mph (Exhibit 13-12)

S = 52.6 mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-526 WB
Agency or Company	Atkins	Junction	4290-WB Off to PaulCantrell WB
Date Performed	3/20/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2013

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Number of Lanes, N	2	Downstream Adj Ramp	
☐ Yes	☐ On	Acceleration Lane Length, L_A		☐ Yes	☐ On
☑ No	☐ Off	Deceleration Lane Length L_D	825	☑ No	☐ Off
L_{up} =	ft	Freeway Volume, V_F	3380	L_{down} =	ft
V_u =	veh/h	Ramp Volume, V_R	1658	V_D =	veh/h
		Freeway Free-Flow Speed, S_{FF}	60.0		
		Ramp Free-Flow Speed, S_{FR}	45.0		

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	3380	0.90	Level	10	0	0.952	1.00	3943
Ramp	1658	0.90	Level	16	0	0.926	1.00	1990
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 1.000 using Equation (Exhibit 13-7)

V_{12} = 3943 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	3943	Exhibit 13-8	4600	No
$V_{FO} = V_F - V_R$	1953	Exhibit 13-8	4600	No
V_R	1990	Exhibit 13-10	2100	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	3943	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = 30.7 (pc/mi/ln)

LOS = D (Exhibit 13-2)

Speed Determination

D_s = 0.477 (Exhibit 13-12)

S_R= 51.4 mph (Exhibit 13-12)

S_0= N/A mph (Exhibit 13-12)

S = 51.4 mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-526 WB
Agency or Company	Atkins	Junction	4300-WB Off to PaulCantrell EB
Date Performed	3/20/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2013

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Number of Lanes, N	2	Downstream Adj Ramp	
☐ Yes	☐ On	Acceleration Lane Length, L_A		☐ Yes	☐ On
☑ No	☐ Off	Deceleration Lane Length L_D	525	☑ No	☐ Off
L_{up} =	ft	Freeway Volume, V_F	1728	L_{down} =	ft
V_u =	veh/h	Ramp Volume, V_R	623	V_D =	veh/h
		Freeway Free-Flow Speed, S_{FF}	60.0		
		Ramp Free-Flow Speed, S_{FR}	25.0		

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	1728	0.90	Level	6	0	0.971	1.00	1978
Ramp	623	0.90	Level	4	0	0.980	1.00	706
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 1.000 using Equation (Exhibit 13-7)

V_{12} = 1978 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	1978	Exhibit 13-8	4600	No
$V_{FO} = V_F - V_R$	1272	Exhibit 13-8	4600	No
V_R	706	Exhibit 13-10	1900	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	1978	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = 16.5 (pc/mi/ln)

LOS = B (Exhibit 13-2)

Speed Determination

D_s = 0.622 (Exhibit 13-12)

S_R= 48.8 mph (Exhibit 13-12)

S_0= N/A mph (Exhibit 13-12)

S = 48.8 mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-526 WB
Agency or Company	Atkins	Junction	4300-WB Off to PaulCantrell EB
Date Performed	3/20/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2013

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Number of Lanes, N	2	Downstream Adj Ramp	
☐ Yes	☐ On	Acceleration Lane Length, L_A		☐ Yes	☐ On
☑ No	☐ Off	Deceleration Lane Length L_D	525	☑ No	☐ Off
L_{up} =	ft	Freeway Volume, V_F	1722	L_{down} =	ft
V_u =	veh/h	Ramp Volume, V_R	663	V_D =	veh/h
		Freeway Free-Flow Speed, S_{FF}	60.0		
		Ramp Free-Flow Speed, S_{FR}	25.0		

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	1722	0.90	Level	4	0	0.980	1.00	1952
Ramp	663	0.90	Level	4	0	0.980	1.00	751
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 1.000 using Equation (Exhibit 13-7)

V_{12} = 1952 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	1952	Exhibit 13-8	4600	No
$V_{FO} = V_F - V_R$	1201	Exhibit 13-8	4600	No
V_R	751	Exhibit 13-10	1900	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	1952	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = 16.3 (pc/mi/ln)

LOS = B (Exhibit 13-2)

Speed Determination

D_s = 0.626 (Exhibit 13-12)

S_R= 48.7 mph (Exhibit 13-12)

S_0= N/A mph (Exhibit 13-12)

S = 48.7 mph (Exhibit 13-13)

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-526 WB*
Agency or Company	*Atkins*	From/To	*4305-PaulCEB Off to PaulCEB On*
Date Performed	*4/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2013*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*1105*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*7*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.966*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*60.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*60.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*635*	pc/h/ln
S	*60.0*	mph
D = v_p / S	*10.6*	pc/mi/ln
LOS	*A*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-526 WB*
Agency or Company	*Atkins*	From/To	*4305-PaulCEB Off to PaulCEB On*
Date Performed	*4/25/2014*	Jurisdiction	
Analysis Time Period	*PM Peak*	Analysis Year	*2013*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*1059*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*4*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.980*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*60.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*60.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*600*	pc/h/ln
S	*60.0*	mph
D = v_p / S	*10.0*	pc/mi/ln
LOS	*A*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-526 WB
Agency or Company	Atkins	Junction	4310-WB On from PaulCantrellEB
Date Performed	4/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2013

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Number of Lanes, N: 2	☐ Yes ☐ On
☑ No ☐ Off	Acceleration Lane Length, L_A: 700	☑ No ☐ Off
L_{up} = ft	Deceleration Lane Length L_D:	L_{down} = ft
V_u = veh/h	Freeway Volume, V_F: 1105	V_D = veh/h
	Ramp Volume, V_R: 239	
	Freeway Free-Flow Speed, S_{FF}: 60.0	
	Ramp Free-Flow Speed, S_{FR}: 45.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	1105	0.90	Level	7	0	0.966	1.00	1271
Ramp	239	0.90	Level	14	0	0.935	1.00	284
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 1.000 using Equation (Exhibit 13-6)

V_{12} = 1271 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	1555	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	1555	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = 13.1 (pc/mi/ln)

LOS = B (Exhibit 13-2)

Speed Determination

M_S = 0.276 (Exibit 13-11)

S_R= 55.0 mph (Exhibit 13-11)

S_0= N/A mph (Exhibit 13-11)

S = 55.0 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-526 WB
Agency or Company	Atkins	Junction	4310-WB On from PaulCantrellEB
Date Performed	4/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2013

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Number of Lanes, N: 2	☐ Yes ☐ On
☑ No ☐ Off	Acceleration Lane Length, L_A: 700	☑ No ☐ Off
L_{up} = ft	Deceleration Lane Length L_D:	L_{down} = ft
V_u = veh/h	Freeway Volume, V_F: 1059	V_D = veh/h
	Ramp Volume, V_R: 192	
	Freeway Free-Flow Speed, S_{FF}: 60.0	
	Ramp Free-Flow Speed, S_{FR}: 45.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	1059	0.90	Level	4	0	0.980	1.00	1200
Ramp	192	0.90	Level	8	0	0.962	1.00	222
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 1.000 using Equation (Exhibit 13-6)

V_{12} = 1200 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	1422	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	1422	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = 12.1 (pc/mi/ln)

LOS = B (Exhibit 13-2)

Speed Determination

M_S = 0.274 (Exibit 13-11)

S_R= 55.1 mph (Exhibit 13-11)

S_0= N/A mph (Exhibit 13-11)

S = 55.1 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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Appendix E
Traffic Analysis Worksheets

2013 Existing

US Highway 17

MAJOR MERGE SEGMENTS ANALYSIS

ATKINS

General Information

Date Performed:	3/20/2014	Freeway/Direction	US 17 NB
Analysis Year	2013	Junction	From I-26 EB & WB
Analysis Time Period:	AM Peak	Segment ID	5010
Project Description:	Navy Base ICTF		

Inputs

	Freeway Upstream of On-Ramp	Freeway Downstream of On-Ramp	On-Ramp
Number of Lanes, N	2	4	2
Free-Flow Speed, FFS (mph)	55	55	55
Volume, V (veh/h)	1,726	2,816	1,090
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	2%	2%	2%
%RVs, P_R	0%	0%	0%

Performance Measures

	Freeway Upstream of On-Ramp	Freeway Downstream of On-Ramp	On-Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.99	0.99	0.99
Demand Flow Rate, v_p (pc/h/ln)	968	790	612
Capacity Flow Rate, c (pc/h/ln)	2,250	2,250	2,200
v/c ratio	0.43	0.35	0.28
	Below Capacity	Below Capacity	Below Capacity

Formulas and Reference Material

$$f_{HV} = \frac{1}{1 + P_T(E_T-1)+P_R(E_R-1)}$$ HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P}$$ HCM 2010, Equation 11-2

Basic Freeway Segments Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
75	2,400
70	2,400
65	2,350
60	2,300
55	2,250

Source: HCM 2010, Exhibit 11-17

Ramp Roadways Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

MAJOR MERGE SEGMENTS ANALYSIS

ATKINS

General Information

Date Performed:	3/20/2014	Freeway/Direction	US 17 NB
Analysis Year	2013	Junction	From I-26 EB & WB
Analysis Time Period:	PM Peak	Segment ID	5010
Project Description:	Navy Base ICTF		

Inputs

	Freeway Upstream of On-Ramp	Freeway Downstream of On-Ramp	On-Ramp
Number of Lanes, N	2	4	2
Free-Flow Speed, FFS (mph)	55	55	55
Volume, V (veh/h)	1,975	2,539	564
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	2%	2%	2%
%RVs, P_R	0%	0%	0%

Performance Measures

	Freeway Upstream of On-Ramp	Freeway Downstream of On-Ramp	On-Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.99	0.99	0.99
Demand Flow Rate, v_p (pc/h/ln)	1,108	712	316
Capacity Flow Rate, c (pc/h/ln)	2,250	2,250	2,200
v/c ratio	0.49	0.32	0.14
	Below Capacity	Below Capacity	Below Capacity

Formulas and Reference Material

$$f_{HV} = \frac{1}{1 + P_T(E_T-1)+P_R(E_R-1)}$$ HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P}$$ HCM 2010, Equation 11-2

Basic Freeway Segments Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
75	2,400
70	2,400
65	2,350
60	2,300
55	2,250

Source: HCM 2010, Exhibit 11-17

Ramp Roadways Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	US-17 NB
Agency or Company	Atkins	Junction	5020-NB On from Meeting
Date Performed	4/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2013

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Number of Lanes, N: 4	☐ Yes ☐ On
☑ No ☐ Off	Acceleration Lane Length, L_A: 1125	☑ No ☐ Off
L_{up} = ft	Deceleration Lane Length L_D:	L_{down} = ft
V_u = veh/h	Freeway Volume, V_F: 2816	V_D = veh/h
	Ramp Volume, V_R: 404	
	Freeway Free-Flow Speed, S_{FF}: 55.0	
	Ramp Free-Flow Speed, S_{FR}: 45.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	2816	0.90	Level	2	0	0.990	1.00	3160
Ramp	404	0.90	Level	13	0	0.939	1.00	478
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 0.437 using Equation (Exhibit 13-6)

V_{12} = 1380 pc/h

V_3 or V_{av34} 890 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	3638	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	1858	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = 12.7 (pc/mi/ln)

LOS = B (Exhibit 13-2)

Speed Determination

M_S = 0.245 (Exibit 13-11)

S_R= 51.8 mph (Exhibit 13-11)

S_0= 53.6 mph (Exhibit 13-11)

S = 52.7 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	US-17 NB
Agency or Company	Atkins	Junction	5020-NB On from Meeting
Date Performed	4/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2013

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Number of Lanes, N: 4	☐ Yes ☐ On
☑ No ☐ Off	Acceleration Lane Length, L_A: 1125	☑ No ☐ Off
L_{up} = ft	Deceleration Lane Length L_D:	L_{down} = ft
V_u = veh/h	Freeway Volume, V_F: 2539	V_D = veh/h
	Ramp Volume, V_R: 727	
	Freeway Free-Flow Speed, S_{FF}: 55.0	
	Ramp Free-Flow Speed, S_{FR}: 45.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	2539	0.90	Level	2	0	0.990	1.00	2849
Ramp	727	0.90	Level	3	0	0.985	1.00	820
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 0.394 using Equation (Exhibit 13-6)

V_{12} = 1123 pc/h

V_3 or V_{av34} 863 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * $V_{12}/2$ ☑ Yes ☐ No

If Yes, V_{12a} = 1139 pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	3669	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	1959	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = 13.3 (pc/mi/ln)

LOS = B (Exhibit 13-2)

Speed Determination

M_S = 0.247 (Exibit 13-11)

S_R= 51.8 mph (Exhibit 13-11)

S_0= 53.7 mph (Exhibit 13-11)

S = 52.7 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * $V_{12}/2$ ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	US-17 NB
Agency or Company	Atkins	Junction	5030-NB On from E Bay
Date Performed	4/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2013

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Number of Lanes, N: 4	☐ Yes ☐ On
☑ No ☐ Off	Acceleration Lane Length, L_A: 925	☑ No ☐ Off
L_{up} = ft	Deceleration Lane Length L_D:	L_{down} = ft
V_u = veh/h	Freeway Volume, V_F: 3220	V_D = veh/h
	Ramp Volume, V_R: 304	
	Freeway Free-Flow Speed, S_{FF}: 55.0	
	Ramp Free-Flow Speed, S_{FR}: 45.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	3220	0.90	Level	3	0	0.985	1.00	3631
Ramp	304	0.90	Level	12	0	0.943	1.00	358
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 0.173 using Equation (Exhibit 13-6)

V_{12} = 628 pc/h

V_3 or V_{av34} 1501 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * $V_{12}/2$ ☑ Yes ☐ No

If Yes, V_{12a} = 1452 pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	3989	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	1810	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = 13.6 (pc/mi/ln)

LOS = B (Exhibit 13-2)

Speed Determination

M_S = 0.262 (Exibit 13-11)

S_R= 51.6 mph (Exhibit 13-11)

S_0= 52.9 mph (Exhibit 13-11)

S = 52.3 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * $V_{12}/2$ ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	US-17 NB
Agency or Company	Atkins	Junction	5030-NB On from E Bay
Date Performed	4/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2013

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Number of Lanes, N: 4	☐ Yes ☐ On
☑ No ☐ Off	Acceleration Lane Length, L_A: 925	☑ No ☐ Off
L_{up} = ft	Deceleration Lane Length L_D:	L_{down} = ft
V_u = veh/h	Freeway Volume, V_F: 3266	V_D = veh/h
	Ramp Volume, V_R: 1062	
	Freeway Free-Flow Speed, S_{FF}: 55.0	
	Ramp Free-Flow Speed, S_{FR}: 45.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	3266	0.90	Level	2	0	0.990	1.00	3665
Ramp	1062	0.90	Level	5	0	0.976	1.00	1210
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 0.067 using Equation (Exhibit 13-6)

V_{12} = 244 pc/h

V_3 or V_{av34} 1710 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * $V_{12}/2$ ☑ Yes ☐ No

If Yes, V_{12a} = 1466 pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	4875	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	2676	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = 20.0 (pc/mi/ln)

LOS = B (Exhibit 13-2)

Speed Determination

M_S = 0.294 (Exibit 13-11)

S_R= 51.2 mph (Exhibit 13-11)

S_0= 52.8 mph (Exhibit 13-11)

S = 51.9 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * $V_{12}/2$ ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*US-17 NB*
Agency or Company	*Atkins*	From/To	*5040-E Bay to SC-703*
Date Performed	*4/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2013*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*3524*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*4*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.980*

Speed Inputs			Calc Speed Adj and FFS		
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f_{LW}		mph
Number of Lanes, N	*4*		f_{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	*55.0*	mph	FFS	*55.0*	mph
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures			Design (N)	
Operational (LOS)			Design (N)	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*998*	pc/h/ln	Design LOS	
			v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h/ln
S	*55.0*	mph	S	mph
D = v_p / S	*18.1*	pc/mi/ln	D = v_p / S	pc/mi/ln
LOS	*C*		Required Number of Lanes, N	

Glossary		Factor Location	
N - Number of lanes	S - Speed	E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
V - Hourly volume	D - Density	E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 11-18	TRD - Page 11-11
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 11-2, 11-3	
DDHV - Directional design hour volume			

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*US-17 NB*
Agency or Company	*Atkins*	From/To	*5040-E Bay to SC-703*
Date Performed	*4/25/2014*	Jurisdiction	
Analysis Time Period	*PM Peak*	Analysis Year	*2013*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*4328*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*3*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.985*

Speed Inputs			Calc Speed Adj and FFS		
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f_{LW}		mph
Number of Lanes, N	*4*		f_{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	*55.0*	mph	FFS	*55.0*	mph
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures			Design (N)	
Operational (LOS)			Design (N)	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1220*	pc/h/ln	Design LOS	
			v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h/ln
S	*55.0*	mph	S	mph
D = v_p / S	*22.2*	pc/mi/ln	D = v_p / S	pc/mi/ln
LOS	*C*		Required Number of Lanes, N	

Glossary		Factor Location	
N - Number of lanes	S - Speed	E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
V - Hourly volume	D - Density	E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 11-18	TRD - Page 11-11
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 11-2, 11-3	
DDHV - Directional design hour volume			

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MAJOR DIVERGE SEGMENTS ANALYSIS

ATKINS

General Information

Date Performed:	3/20/2014	Freeway/Direction	US-17 NB
Analysis Year	2013	Junction	Off to SC-703
Analysis Time Period:	AM Peak	Segment ID	5050
Project Description:	Navy Base ICTF		

Inputs

	Freeway Upstream of Off-Ramp	Freeway Downstream of Off-Ramp	Off-Ramp
Number of Lanes, N	4	2	2
Free-Flow Speed, FFS (mph)	55	45	40
Volume, V (veh/h)	3,524	2,499	1,025
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	4%	2%	8%
%RVs, P_R	0%	0%	0%

Performance Measures

	Upstream of Off-Ramp	Downstream of Off-Ramp	Off-Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.98	0.99	0.96
Demand Flow Rate, v_p (pc/h/ln)	998	1,402	592
Capacity Flow Rate, c (pc/h/ln)	2,200	2,100	2,000
v/c ratio	0.45	0.67	0.30
Density, D_{MD} (pc/mi/ln)	17.5	24.5	10.4
LOS	B	C	B

Formulas and Reference Material

$$f_{HV} = \frac{1}{1+P_T(E_T-1)+P_R(E_R-1)}$$ HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P}$$ HCM 2010, Equation 11-2

$$D_{MD} = \frac{0.0175*v_f}{N}$$ HCM 2010, Equation 13-26

Ramp Roadways Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

Diverge LOS Thresholds

LOS	Density (pc/mi/ln)
A	≤10
B	>10-20
C	>20-28
D	>28-35
E	>35
F	v/c > 1

Source: HCM 2010, Exhibit 13-2

MAJOR DIVERGE SEGMENTS ANALYSIS

ATKINS

General Information

Date Performed:	3/20/2014	Freeway/Direction	US-17 NB
Analysis Year	2013	Junction	Off to SC-703
Analysis Time Period:	PM Peak	Segment ID	5050
Project Description:	Navy Base ICTF		

Inputs

	Freeway Upstream of Off-Ramp	Freeway Downstream of Off-Ramp	Off-Ramp
Number of Lanes, N	4	2	2
Free-Flow Speed, FFS (mph)	55	45	40
Volume, V (veh/h)	4,328	2,882	1,446
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	3%	2%	5%
%RVs, P_R	0%	0%	0%

Performance Measures

	Upstream of Off-Ramp	Downstream of Off-Ramp	Off-Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.99	0.99	0.98
Demand Flow Rate, v_p (pc/h/ln)	1,220	1,617	823
Capacity Flow Rate, c (pc/h/ln)	2,200	2,100	2,000
v/c ratio	0.55	0.77	0.41
Density, D_{MD} (pc/mi/ln)	21.4	28.3	14.4
LOS	C	D	B

Formulas and Reference Material

$$f_{HV} = \frac{1}{1+P_T(E_T-1)+P_R(E_R-1)}$$ HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P}$$ HCM 2010, Equation 11-2

$$D_{MD} = \frac{0.0175*v_f}{N}$$ HCM 2010, Equation 13-26

Ramp Roadways Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

Diverge LOS Thresholds

LOS	Density (pc/mi/ln)
A	≤10
B	>10-20
C	>20-28
D	>28-35
E	>35
F	v/c > 1

Source: HCM 2010, Exhibit 13-2

RAMP ADD OR DROP LANE ANALYSIS (MAINLINE <55 MPH)

ATKINS

General Information

Date Performed:	3/20/2014	Freeway/Direction	US-17 NB
Analysis Year	2013	Junction	Off to Bowman
Analysis Time Period:	AM Peak	Segment ID	5060
Project Description:	Navy Base ICTF		

Inputs

	Mainline Upstream Ramp	Mainline Downstream Ramp	Ramp
Number of Lanes, N	3	2	1
Free-Flow Speed, FFS (mph)	45	45	45
Volume, V (veh/h)	1,934	1,630	304
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	2%	2%	4%
%RVs, P_R	0%	0%	0%

Performance Measures

	Upstream of Off-Ramp	Downstream of Off-Ramp	Off-Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.99	0.99	0.98
Demand Flow Rate, v_p (pc/h/ln)	723	915	345
Capacity Flow Rate, c (pc/h/ln)	2,100	2,100	2,100
v/c ratio	0.34	0.44	0.16
Density, D_{MD} (pc/mi/ln)	12.7	16.0	6.0
LOS	B	B	A

Formulas and Reference Material

$$f_{HV} = \frac{1}{1+P_T(E_T-1)+P_R(E_R-1)}$$ HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P}$$ HCM 2010, Equation 11-2

$$D_{MD} = \frac{0.0175*v_f}{N}$$ HCM 2010, Equation 13-26

Ramp Roadways Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

Diverge LOS Thresholds

LOS	Density (pc/mi/ln)
A	≤10
B	>10-20
C	>20-28
D	>28-35
E	>35
F	v/c > 1

Source: HCM 2010, Exhibit 13-2

RAMP ADD OR DROP LANE ANALYSIS (MAINLINE <55 MPH)

ATKINS

General Information

Date Performed:	3/20/2014	Freeway/Direction	US-17 NB
Analysis Year	2013	Junction	Off to Bowman
Analysis Time Period:	PM Peak	Segment ID	5060
Project Description:	Navy Base ICTF		

Inputs

	Mainline Upstream Ramp	Mainline Downstream Ramp	Ramp
Number of Lanes, N	3	2	1
Free-Flow Speed, FFS (mph)	45	45	45
Volume, V (veh/h)	2,741	2,423	318
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	2%	2%	3%
%RVs, P_R	0%	0%	0%

Performance Measures

	Upstream of Off-Ramp	Downstream of Off-Ramp	Off-Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.99	0.99	0.99
Demand Flow Rate, v_p (pc/h/ln)	1,025	1,360	359
Capacity Flow Rate, c (pc/h/ln)	2,100	2,100	2,100
v/c ratio	0.49	0.65	0.17
Density, D_{MD} (pc/mi/ln)	17.9	23.8	6.3
LOS	B	C	A

Formulas and Reference Material

$$f_{HV} = \frac{1}{1+P_T(E_T-1)+P_R(E_R-1)}$$ HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P}$$ HCM 2010, Equation 11-2

$$D_{MD} = \frac{0.0175*v_f}{N}$$ HCM 2010, Equation 13-26

Ramp Roadways Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

Diverge LOS Thresholds

LOS	Density (pc/mi/ln)
A	≤10
B	>10-20
C	>20-28
D	>28-35
E	>35
F	v/c > 1

Source: HCM 2010, Exhibit 13-2

BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*US-17 NB*
Agency or Company	*Atkins*	From/To	*5065-Bowman Off to Bowman On*
Date Performed	*4/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2013*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*1630*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*2*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.990*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*55.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*55.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*915*	pc/h/ln
S	*55.0*	mph
D = v_p / S	*16.6*	pc/mi/ln
LOS	*B*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*US-17 NB*
Agency or Company	*Atkins*	From/To	*5065-Bowman Off to Bowman On*
Date Performed	*4/25/2014*	Jurisdiction	
Analysis Time Period	*PM Peak*	Analysis Year	*2013*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*2423*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*2*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.990*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*55.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*55.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1360*	pc/h/ln
S	*55.0*	mph
D = v_p / S	*24.7*	pc/mi/ln
LOS	*C*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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Navy Base ICTF

FREEWAY WEAVING WORKSHEET

General Information

Analyst	AJR
Agency/Company	Atkins
Date Performed	3/20/2014
Analysis Time Period	AM Peak

Site Information

Freeway/Dir of Travel	US-17 NB
Weaving Segment Location	5070-Bowman On to I-526 WB Off
Analysis Year	2013

Project Description *Navy Base ICTF*

Inputs

Weaving configuration	One-Sided
Weaving number of lanes, N	3
Weaving segment length, L_S	825ft
Freeway free-flow speed, FFS	45 mph
Segment type	C-D Roadway/ Multilane Highways
Freeway minimum speed, S_{MIN}	15
Freeway maximum capacity, C_{IFL}	2250
Terrain type	Level

Conversions to pc/h Under Base Conditions

	V (veh/h)	PHF	Truck (%)	RV (%)	E_T	E_R	f_{HV}	f_p	v (pc/h)
V_{FF}	892	0.90	2	0	1.5	1.2	0.990	1.00	1001
V_{RF}	142	0.90	12	0	1.5	1.2	0.943	1.00	167
V_{FR}	738	0.90	3	0	1.5	1.2	0.985	1.00	832
V_{RR}	117	0.90	25	0	1.5	1.2	0.889	1.00	146
V_{NW}	1147							V =	2146
V_W	999								
VR	0.466								

Configuration Characteristics

Minimum maneuver lanes, N_{WL}	2 lc
Interchange density, ID	0.3 int/mi
Minimum RF lane changes, LC_{RF}	1 lc/pc
Minimum FR lane changes, LC_{FR}	1 lc/pc
Minimum RR lane changes, LC_{RR}	lc/pc
Minimum weaving lane changes, LC_{MIN}	999 lc/h
Weaving lane changes, LC_W	1098 lc/h
Non-weaving lane changes, LC_{NW}	106 lc/h
Total lane changes, LC_{ALL}	1204 lc/h
Non-weaving vehicle index, I_{NW}	28

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment flow rate, v	2146 pc/h
Weaving segment capacity, c_w	5105 veh/h
Weaving segment v/c ratio	0.416
Weaving segment density, D	19.9 pc/mi/ln
Level of Service, LOS	B
Weaving intensity factor, W	0.305
Weaving segment speed, S	36.0 mph
Average weaving speed, S_W	38.0 mph
Average non-weaving speed, S_{NW}	34.4 mph
Maximum weaving length, L_{MAX}	7426 ft

Notes

a. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments".
b. For volumes that exceed the weaving segment capacity, the level of service is "F".

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Navy Base ICTF

FREEWAY WEAVING WORKSHEET

General Information

Analyst	AJR
Agency/Company	Atkins
Date Performed	3/20/2014
Analysis Time Period	PM Peak

Site Information

Freeway/Dir of Travel	US-17 NB
Weaving Segment Location	5070-Bowman On to I-526 WB Off
Analysis Year	2013

Project Description *Navy Base ICTF*

Inputs

Weaving configuration	One-Sided
Weaving number of lanes, N	3
Weaving segment length, L_S	825ft
Freeway free-flow speed, FFS	45 mph
Segment type	C-D Roadway/ Multilane Highways
Freeway minimum speed, S_{MIN}	15
Freeway maximum capacity, C_{IFL}	2250
Terrain type	Level

Conversions to pc/h Under Base Conditions

	V (veh/h)	PHF	Truck (%)	RV (%)	E_T	E_R	f_{HV}	f_p	v (pc/h)
V_{FF}	1721	0.90	2	0	1.5	1.2	0.990	1.00	1931
V_{RF}	327	0.90	15	0	1.5	1.2	0.930	1.00	391
V_{FR}	702	0.90	2	0	1.5	1.2	0.990	1.00	788
V_{RR}	133	0.90	17	0	1.5	1.2	0.922	1.00	160
V_{NW}	2091							V =	3270
V_W	1179								
VR	0.361								

Configuration Characteristics

Minimum maneuver lanes, N_{WL}	2 lc
Interchange density, ID	0.3 int/mi
Minimum RF lane changes, LC_{RF}	1 lc/pc
Minimum FR lane changes, LC_{FR}	1 lc/pc
Minimum RR lane changes, LC_{RR}	lc/pc
Minimum weaving lane changes, LC_{MIN}	1179 lc/h
Weaving lane changes, LC_W	1278 lc/h
Non-weaving lane changes, LC_{NW}	300 lc/h
Total lane changes, LC_{ALL}	1578 lc/h
Non-weaving vehicle index, I_{NW}	52

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment flow rate, v	3270 pc/h
Weaving segment capacity, c_w	5453 veh/h
Weaving segment v/c ratio	0.594
Weaving segment density, D	33.0 pc/mi/ln
Level of Service, LOS	D
Weaving intensity factor, W	0.377
Weaving segment speed, S	33.1 mph
Average weaving speed, S_W	36.8 mph
Average non-weaving speed, S_{NW}	31.3 mph
Maximum weaving length, L_{MAX}	6242 ft

Notes

a. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments".
b. For volumes that exceed the weaving segment capacity, the level of service is "F".

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*US-17 NB*
Agency or Company	*Atkins*	From/To	*5075-526 WB Off to 526 WB On*
Date Performed	*4/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2013*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*1034*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*3*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.985*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*55.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*55.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*583*	pc/h/ln
S	*55.0*	mph
D = v_p / S	*10.6*	pc/mi/ln
LOS	*A*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*US-17 NB*
Agency or Company	*Atkins*	From/To	*5075-526 WB Off to 526 WB On*
Date Performed	*4/25/2014*	Jurisdiction	
Analysis Time Period	*PM Peak*	Analysis Year	*2013*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*2048*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*4*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.980*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*55.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*55.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1161*	pc/h/ln
S	*55.0*	mph
D = v_p / S	*21.1*	pc/mi/ln
LOS	*C*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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RAMP ADD OR DROP LANE ANALYSIS (MAINLINE <55 MPH)

ATKINS

General Information

Date Performed:	3/20/2014	Freeway/Direction	US 17 NB
Analysis Year	2013	Junction	From I-526 WB
Analysis Time Period:	AM Peak	Segment ID	5080
Project Description:	Navy Base ICTF		

Inputs

	Mainline Upstream Ramp	Mainline Downstream Ramp	Ramp
Number of Lanes, N	2	3	1
Free-Flow Speed, FFS (mph)	45	45	45
Volume, V (veh/h)	1,034	1,332	298
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	3%	5%	14%
%RVs, P_R	0%	0%	0%

Performance Measures

	Upstream of Off-Ramp	Downstream of Off-Ramp	Off-Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.99	0.98	0.93
Demand Flow Rate, v_p (pc/h/ln)	583	506	354
Capacity Flow Rate, c (pc/h/ln)	2,100	2,100	2,100
v/c ratio	0.28	0.24	0.17
Density, D_{MD} (pc/mi/ln)	10.2	8.9	6.2
LOS	B	A	A

Formulas and Reference Material

$$f_{HV} = \frac{1}{1+P_T(E_T-1)+P_R(E_R-1)}$$ HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P}$$ HCM 2010, Equation 11-2

$$D_{MD} = \frac{0.0175*v_f}{N}$$ HCM 2010, Equation 13-26

Ramp Roadways Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

Diverge LOS Thresholds

LOS	Density (pc/mi/ln)
A	≤10
B	>10-20
C	>20-28
D	>28-35
E	>35
F	v/c > 1

Source: HCM 2010, Exhibit 13-2

RAMP ADD OR DROP LANE ANALYSIS (MAINLINE <55 MPH)

ATKINS

General Information

Date Performed:	3/20/2014	Freeway/Direction	US 17 NB
Analysis Year	2013	Junction	From I-526 WB
Analysis Time Period:	PM Peak	Segment ID	5080
Project Description:	Navy Base ICTF		

Inputs

	Mainline Upstream Ramp	Mainline Downstream Ramp	Ramp
Number of Lanes, N	2	3	1
Free-Flow Speed, FFS (mph)	45	45	45
Volume, V (veh/h)	2,048	2,474	426
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	4%	4%	7%
%RVs, P_R	0%	0%	0%

Performance Measures

	Upstream of Off-Ramp	Downstream of Off-Ramp	Off-Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.98	0.98	0.97
Demand Flow Rate, v_p (pc/h/ln)	1,161	935	490
Capacity Flow Rate, c (pc/h/ln)	2,100	2,100	2,100
v/c ratio	0.55	0.45	0.23
Density, D_{MD} (pc/mi/ln)	20.3	16.4	8.6
LOS	C	B	A

Formulas and Reference Material

$$f_{HV} = \frac{1}{1+P_T(E_T-1)+P_R(E_R-1)}$$ HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P}$$ HCM 2010, Equation 11-2

$$D_{MD} = \frac{0.0175*v_f}{N}$$ HCM 2010, Equation 13-26

Ramp Roadways Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

Diverge LOS Thresholds

LOS	Density (pc/mi/ln)
A	≤10
B	>10-20
C	>20-28
D	>28-35
E	>35
F	v/c > 1

Source: HCM 2010, Exhibit 13-2

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	US-17 SB
Agency or Company	Atkins	Junction	6010-Off to I-526 EB
Date Performed	3/20/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2013

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Freeway Number of Lanes, N: 2	☐ Yes ☐ On
☑ No ☐ Off	Ramp Number of Lanes, N: 1	☑ No ☐ Off
L_{up} = ft	Acceleration Lane Length, L_A	L_{down} = ft
V_u = veh/h	Deceleration Lane Length L_D: 450	V_D = veh/h
	Freeway Volume, V_F: 1925	
	Ramp Volume, V_R: 350	
	Freeway Free-Flow Speed, S_{FF}: 55.0	
	Ramp Free-Flow Speed, S_{FR}: 25.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	1925	0.90	Level	2	0	0.990	1.00	2160
Ramp	350	0.90	Level	5	0	0.976	1.00	399
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 1.000 using Equation (Exhibit 13-7)

V_{12} = 2160 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	2160	Exhibit 13-8	4500	No
$V_{FO} = V_F - V_R$	1761	Exhibit 13-8	4500	No
V_R	399	Exhibit 13-10	1900	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	2160	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = 18.8 (pc/mi/ln)

LOS = B (Exhibit 13-2)

Speed Determination

D_s = 0.594 (Exhibit 13-12)

S_R= 47.3 mph (Exhibit 13-12)

S_0= N/A mph (Exhibit 13-12)

S = 47.3 mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	US-17 SB
Agency or Company	Atkins	Junction	6010-Off to I-526 EB
Date Performed	3/20/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2013

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Freeway Number of Lanes, N	2	Downstream Adj Ramp	
☐ Yes	☐ On	Ramp Number of Lanes, N	1	☐ Yes	☐ On
☑ No	☐ Off	Acceleration Lane Length, L_A		☑ No	☐ Off
L_{up} =	ft	Deceleration Lane Length L_D	450	L_{down} =	ft
V_u =	veh/h	Freeway Volume, V_F	1718	V_D =	veh/h
		Ramp Volume, V_R	282		
		Freeway Free-Flow Speed, S_{FF}	55.0		
		Ramp Free-Flow Speed, S_{FR}	25.0		

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	1718	0.90	Level	2	0	0.990	1.00	1928
Ramp	282	0.90	Level	4	0	0.980	1.00	320
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 1.000 using Equation (Exhibit 13-7)

V_{12} = 1928 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	1928	Exhibit 13-8	4500	No
$V_{FO} = V_F - V_R$	1608	Exhibit 13-8	4500	No
V_R	320	Exhibit 13-10	1900	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	1928	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = 16.8 (pc/mi/ln)

LOS = B (Exhibit 13-2)

Speed Determination

D_s = 0.587 (Exhibit 13-12)

S_R= 47.4 mph (Exhibit 13-12)

S_0= N/A mph (Exhibit 13-12)

S = 47.4 mph (Exhibit 13-13)

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*US 17 SB*
Agency or Company	*Atkins*	From/To	*6015-526 EB Off to 526 EB On*
Date Performed	*4/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2013*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*1575*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*2*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.990*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*3*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*55.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*55.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*589*	pc/h/ln
S	*55.0*	mph
D = v_p / S	*10.7*	pc/mi/ln
LOS	*A*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*US-17 SB*
Agency or Company	*Atkins*	From/To	*6015-526 EB Off to 526 EB On*
Date Performed	*4/25/2014*	Jurisdiction	
Analysis Time Period	*PM Peak*	Analysis Year	*2013*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*1436*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*2*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.990*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*3*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*55.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*55.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*537*	pc/h/ln
S	*55.0*	mph
D = v_p / S	*9.8*	pc/mi/ln
LOS	*A*	

Design (N)

Design (N)

Design LOS	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h/ln
S	mph
D = v_p / S	pc/mi/ln
Required Number of Lanes, N	

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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Navy Base ICTF

FREEWAY WEAVING WORKSHEET

General Information

Analyst	AJR
Agency/Company	Atkins
Date Performed	3/20/2014
Analysis Time Period	AM Peak

Site Information

Freeway/Dir of Travel	US-17 SB
Weaving Segment Location	6020-I-526 EB On to Bowman Off
Analysis Year	2013

Project Description *Navy Base ICTF*

Inputs

Weaving configuration	One-Sided
Weaving number of lanes, N	4
Weaving segment length, L_S	650ft
Freeway free-flow speed, FFS	45 mph
Segment type	C-D Roadway/ Multilane Highways
Freeway minimum speed, S_{MIN}	15
Freeway maximum capacity, C_{IFL}	2250
Terrain type	Level

Conversions to pc/h Under Base Conditions

	V (veh/h)	PHF	Truck (%)	RV (%)	E_T	E_R	f_{HV}	f_p	v (pc/h)
V_{FF}	1368	0.90	2	0	1.5	1.2	0.990	1.00	1535
V_{RF}	868	0.90	6	0	1.5	1.2	0.971	1.00	993
V_{FR}	207	0.90	8	0	1.5	1.2	0.962	1.00	239
V_{RR}	131	0.90	40	0	1.5	1.2	0.833	1.00	175
V_{NW}	1710							V =	2942
V_W	1232								
VR	0.419								

Configuration Characteristics

Minimum maneuver lanes, N_{WL}	3 lc
Interchange density, ID	0.3 int/mi
Minimum RF lane changes, LC_{RF}	1 lc/pc
Minimum FR lane changes, LC_{FR}	0 lc/pc
Minimum RR lane changes, LC_{RR}	lc/pc
Minimum weaving lane changes, LC_{MIN}	993 lc/h
Weaving lane changes, LC_W	1137 lc/h
Non-weaving lane changes, LC_{NW}	0 lc/h
Total lane changes, LC_{ALL}	1137 lc/h
Non-weaving vehicle index, I_{NW}	33

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment flow rate, v	2942 pc/h
Weaving segment capacity, c_w	7493 veh/h
Weaving segment v/c ratio	0.389
Weaving segment density, D	20.7 pc/mi/ln
Level of Service, LOS	B
Weaving intensity factor, W	0.351
Weaving segment speed, S	35.5 mph
Average weaving speed, S_W	37.2 mph
Average non-weaving speed, S_{NW}	34.3 mph
Maximum weaving length, L_{MAX}	5326 ft

Notes

a. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments".
b. For volumes that exceed the weaving segment capacity, the level of service is "F".

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Navy Base ICTF

FREEWAY WEAVING WORKSHEET

General Information

Analyst	AJR
Agency/Company	Atkins
Date Performed	3/20/2014
Analysis Time Period	PM Peak

Site Information

Freeway/Dir of Travel	US-17 SB
Weaving Segment Location	6020-I-526 EB On to Bowman Off
Analysis Year	2013

Project Description *Navy Base ICTF*

Inputs

Weaving configuration	One-Sided
Weaving number of lanes, N	4
Weaving segment length, L_S	650ft
Freeway free-flow speed, FFS	45 mph
Segment type	C-D Roadway/ Multilane Highways
Freeway minimum speed, S_{MIN}	15
Freeway maximum capacity, C_{IFL}	2250
Terrain type	Level

Conversions to pc/h Under Base Conditions

	V (veh/h)	PHF	Truck (%)	RV (%)	E_T	E_R	f_{HV}	f_p	v (pc/h)
V_{FF}	1226	0.90	2	0	1.5	1.2	0.990	1.00	1376
V_{RF}	835	0.90	5	0	1.5	1.2	0.976	1.00	951
V_{FR}	210	0.90	8	0	1.5	1.2	0.962	1.00	243
V_{RR}	144	0.90	33	0	1.5	1.2	0.858	1.00	186
V_{NW}	1562							V =	2756
V_W	1194								
VR	0.433								

Configuration Characteristics

Minimum maneuver lanes, N_{WL}	3 lc
Interchange density, ID	0.3 int/mi
Minimum RF lane changes, LC_{RF}	1 lc/pc
Minimum FR lane changes, LC_{FR}	0 lc/pc
Minimum RR lane changes, LC_{RR}	lc/pc
Minimum weaving lane changes, LC_{MIN}	951 lc/h
Weaving lane changes, LC_W	1095 lc/h
Non-weaving lane changes, LC_{NW}	0 lc/h
Total lane changes, LC_{ALL}	1095 lc/h
Non-weaving vehicle index, I_{NW}	30

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment flow rate, v	2756 pc/h
Weaving segment capacity, c_w	7446 veh/h
Weaving segment v/c ratio	0.366
Weaving segment density, D	19.2 pc/mi/ln
Level of Service, LOS	B
Weaving intensity factor, W	0.341
Weaving segment speed, S	35.9 mph
Average weaving speed, S_W	37.4 mph
Average non-weaving speed, S_{NW}	34.8 mph
Maximum weaving length, L_{MAX}	5491 ft

Notes

a. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments".
b. For volumes that exceed the weaving segment capacity, the level of service is "F".

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*US-17 SB*
Agency or Company	*Atkins*	From/To	*6025-Bowman Off to Bowman On*
Date Performed	*4/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2013*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*2236*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*3*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.985*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*3*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*55.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*55.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*841*	pc/h/ln
S	*55.0*	mph
D = v_p / S	*15.3*	pc/mi/ln
LOS	*B*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*US-17 SB*
Agency or Company	*Atkins*	From/To	*6025-Bowman Off to Bowman On*
Date Performed	*4/25/2014*	Jurisdiction	
Analysis Time Period	*PM Peak*	Analysis Year	*2013*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*2061*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*3*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.985*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*3*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*55.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*55.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*775*	pc/h/ln
S	*55.0*	mph
D = v_p / S	*14.1*	pc/mi/ln
LOS	*B*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	US-17 SB
Agency or Company	Atkins	Junction	6030-SB On from Bowman
Date Performed	4/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2013

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On		☐ Yes ☐ On
☑ No ☐ Off		☑ No ☐ Off
L_{up} = ft		L_{down} = ft
V_u = veh/h		V_D = veh/h

Freeway Number of Lanes, N	3
Ramp Number of Lanes, N	1
Acceleration Lane Length, L_A	875
Deceleration Lane Length L_D	
Freeway Volume, V_F	2236
Ramp Volume, V_R	318
Freeway Free-Flow Speed, S_{FF}	55.0
Ramp Free-Flow Speed, S_{FR}	45.0

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	2236	0.90	Level	3	0	0.985	1.00	2522
Ramp	318	0.90	Level	2	0	0.990	1.00	357
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 0.602 using Equation (Exhibit 13-6)

V_{12} = 1518 pc/h

V_3 or V_{av34} 1004 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * $V_{12}/2$ ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	2879	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	1875	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = 14.4 (pc/mi/ln)

LOS = B (Exhibit 13-2)

Speed Determination

M_S = 0.268 (Exibit 13-11)

S_R= 51.5 mph (Exhibit 13-11)

S_0= 53.2 mph (Exhibit 13-11)

S = 52.1 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * $V_{12}/2$ ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	US-17 SB
Agency or Company	Atkins	Junction	6030-SB On from Bowman
Date Performed	4/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2013

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Freeway Number of Lanes, N: 3	☐ Yes ☐ On
☑ No ☐ Off	Ramp Number of Lanes, N: 1	☑ No ☐ Off
L_{up} = ft	Acceleration Lane Length, L_A: 875	L_{down} = ft
V_u = veh/h	Deceleration Lane Length L_D:	V_D = veh/h
	Freeway Volume, V_F: 2061	
	Ramp Volume, V_R: 324	
	Freeway Free-Flow Speed, S_{FF}: 55.0	
	Ramp Free-Flow Speed, S_{FR}: 45.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	2061	0.90	Level	3	0	0.985	1.00	2324
Ramp	324	0.90	Level	4	0	0.980	1.00	367
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 0.602 using Equation (Exhibit 13-6)

V_{12} = 1399 pc/h

V_3 or V_{av34} 925 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * $V_{12}/2$ ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	2691	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	1766	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = 13.6 (pc/mi/ln)

LOS = B (Exhibit 13-2)

Speed Determination

M_S = 0.265 (Exibit 13-11)

S_R= 51.6 mph (Exhibit 13-11)

S_0= 53.5 mph (Exhibit 13-11)

S = 52.2 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * $V_{12}/2$ ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	US-17 SB
Agency or Company	Atkins	Junction	6035-SB On from Wingo Way
Date Performed	4/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2013

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Number of Lanes, N: 2	☐ Yes ☐ On
☑ No ☐ Off	Acceleration Lane Length, L_A: 875	☑ No ☐ Off
L_{up} = ft	Deceleration Lane Length L_D:	L_{down} = ft
V_u = veh/h	Freeway Volume, V_F: 2079	V_D = veh/h
	Ramp Volume, V_R: 745	
	Freeway Free-Flow Speed, S_{FF}: 55.0	
	Ramp Free-Flow Speed, S_{FR}: 45.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	2079	0.90	Level	2	0	0.990	1.00	2333
Ramp	745	0.90	Level	2	0	0.990	1.00	836
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 1.000 using Equation (Exhibit 13-6)

V_{12} = 2333 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	3169	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	3169	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = 24.3 (pc/mi/ln)

LOS = C (Exhibit 13-2)

Speed Determination

M_S = 0.335 (Exibit 13-11)

S_R= 50.6 mph (Exhibit 13-11)

S_0= N/A mph (Exhibit 13-11)

S = 50.6 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	US-17 SB
Agency or Company	Atkins	Junction	6035-SB On from Wingo Way
Date Performed	4/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2013

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Number of Lanes, N: 2	☐ Yes ☐ On
☑ No ☐ Off	Acceleration Lane Length, L_A: 875	☑ No ☐ Off
L_{up} = ft	Deceleration Lane Length L_D:	L_{down} = ft
V_u = veh/h	Freeway Volume, V_F: 2034	V_D = veh/h
	Ramp Volume, V_R: 759	
	Freeway Free-Flow Speed, S_{FF}: 55.0	
	Ramp Free-Flow Speed, S_{FR}: 45.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	2034	0.90	Level	2	0	0.990	1.00	2283
Ramp	759	0.90	Level	3	0	0.985	1.00	856
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 1.000 using Equation (Exhibit 13-6)

V_{12} = 2283 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	3139	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	3139	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = 24.1 (pc/mi/ln)

LOS = C (Exhibit 13-2)

Speed Determination

M_S = 0.332 (Exibit 13-11)

S_R= 50.7 mph (Exhibit 13-11)

S_0= N/A mph (Exhibit 13-11)

S = 50.7 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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MAJOR MERGE SEGMENTS ANALYSIS

ATKINS

General Information

Date Performed:	3/20/2014	Freeway/Direction	US 17 SB
Analysis Year	2013	Junction	From SC-703
Analysis Time Period:	AM Peak	Segment ID	6040
Project Description:	Navy Base ICTF		

Inputs

	Freeway Upstream of On-Ramp	Freeway Downstream of On-Ramp	On-Ramp
Number of Lanes, N	2	4	2
Free-Flow Speed, FFS (mph)	55	55	40
Volume, V (veh/h)	2,824	4,083	1,259
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	2%	3%	7%
%RVs, P_R	0%	0%	0%

Performance Measures

	Freeway Upstream of On-Ramp	Freeway Downstream of On-Ramp	On-Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.99	0.99	0.97
Demand Flow Rate, v_p (pc/h/ln)	1,585	1,151	724
Capacity Flow Rate, c (pc/h/ln)	2,250	2,250	2,000
v/c ratio	0.70	0.51	0.36
	Below Capacity	Below Capacity	Below Capacity

Formulas and Reference Material

$$f_{HV} = \frac{1}{1+P_T(E_T-1)+P_R(E_R-1)}$$

HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P}$$

HCM 2010, Equation 11-2

Basic Freeway Segments Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
75	2,400
70	2,400
65	2,350
60	2,300
55	2,250

Source: HCM 2010, Exhibit 11-17

Ramp Roadways Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

MAJOR MERGE SEGMENTS ANALYSIS

ATKINS

General Information

Date Performed:	3/20/2014	Freeway/Direction	US 17 SB
Analysis Year	2013	Junction	From SC-703
Analysis Time Period:	PM Peak	Segment ID	6040
Project Description:	Navy Base ICTF		

Inputs

	Freeway Upstream of On-Ramp	Freeway Downstream of On-Ramp	On-Ramp
Number of Lanes, N	2	4	2
Free-Flow Speed, FFS (mph)	55	55	40
Volume, V (veh/h)	2,793	3,916	1,123
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	2%	4%	7%
%RVs, P_R	0%	0%	0%

Performance Measures

	Freeway Upstream of On-Ramp	Freeway Downstream of On-Ramp	On-Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.99	0.98	0.97
Demand Flow Rate, v_p (pc/h/ln)	1,567	1,110	646
Capacity Flow Rate, c (pc/h/ln)	2,250	2,250	2,000
v/c ratio	0.70	0.49	0.32
	Below Capacity	Below Capacity	Below Capacity

Formulas and Reference Material

$$f_{HV} = \frac{1}{1+P_T(E_T-1)+P_R(E_R-1)}$$ HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P}$$ HCM 2010, Equation 11-2

Basic Freeway Segments Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
75	2,400
70	2,400
65	2,350
60	2,300
55	2,250

Source: HCM 2010, Exhibit 11-17

Ramp Roadways Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*US-17 SB*
Agency or Company	*Atkins*	From/To	*6045-SC-703 to E Bay*
Date Performed	*4/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2013*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*4083*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*3*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.985*

Speed Inputs			Calc Speed Adj and FFS		
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f_{LW}		mph
Number of Lanes, N	*4*		f_{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	*55.0*	mph	FFS	*55.0*	mph
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures			Design (N)	
Operational (LOS)			Design (N)	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1151*	pc/h/ln	Design LOS	
			v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h/ln
S	*55.0*	mph	S	mph
D = v_p / S	*20.9*	pc/mi/ln	D = v_p / S	pc/mi/ln
LOS	*C*		Required Number of Lanes, N	

Glossary		Factor Location	
N - Number of lanes	S - Speed	E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
V - Hourly volume	D - Density	E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 11-18	TRD - Page 11-11
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 11-2, 11-3	
DDHV - Directional design hour volume			

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*US-17 SB*
Agency or Company	*Atkins*	From/To	*6045-SC-703 to E Bay*
Date Performed	*4/25/2014*	Jurisdiction	
Analysis Time Period	*PM Peak*	Analysis Year	*2013*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*3916*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*4*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.980*

Speed Inputs			Calc Speed Adj and FFS		
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f_{LW}		mph
Number of Lanes, N	*4*		f_{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	*55.0*	mph	FFS	*55.0*	mph
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures			Design (N)	
Operational (LOS)			Design (N)	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1110*	pc/h/ln	Design LOS	
			v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h/ln
S	*55.0*	mph	S	mph
D = v_p / S	*20.2*	pc/mi/ln	D = v_p / S	pc/mi/ln
LOS	*C*		Required Number of Lanes, N	

Glossary		Factor Location	
N - Number of lanes	S - Speed	E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
V - Hourly volume	D - Density	E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 11-18	TRD - Page 11-11
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 11-2, 11-3	
DDHV - Directional design hour volume			

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	US-17 SB
Agency or Company	Atkins	Junction	6050-Off to Morrison
Date Performed	3/20/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2013

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Freeway Number of Lanes, N: 4	☑ Yes ☐ On
☑ No ☐ Off	Ramp Number of Lanes, N: 1	☐ No ☑ Off
L_{up} = ft	Acceleration Lane Length, L_A	L_{down} = 885 ft
V_u = veh/h	Deceleration Lane Length L_D: 175	V_D = 458 veh/h
	Freeway Volume, V_F: 4083	
	Ramp Volume, V_R: 493	
	Freeway Free-Flow Speed, S_{FF}: 55.0	
	Ramp Free-Flow Speed, S_{FR}: 45.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	4083	0.90	Level	3	0	0.985	1.00	4605
Ramp	493	0.90	Level	7	0	0.966	1.00	567
UpStream								
DownStream	458	0.90	Level	7	0	0.966	1.00	527

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 0.436 using Equation (Exhibit 13-7)

V_{12} = 2328 pc/h

V_3 or V_{av34} 1138 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	4605	Exhibit 13-8	9000	No
$V_{FO} = V_F - V_R$	4038	Exhibit 13-8	9000	No
V_R	567	Exhibit 13-10	2100	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	2328	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = 22.7 (pc/mi/ln)

LOS = C (Exhibit 13-2)

Speed Determination

D_s = 0.349 (Exhibit 13-12)

S_R= 50.5 mph (Exhibit 13-12)

S_0= 59.8 mph (Exhibit 13-12)

S = 54.7 mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	US-17 SB
Agency or Company	Atkins	Junction	6050-Off to Morrison
Date Performed	3/20/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2013

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp

☐ Yes ☐ On

☑ No ☐ Off

L_{up} = ft

V_u = veh/h

Freeway Number of Lanes, N	4
Ramp Number of Lanes, N	1
Acceleration Lane Length, L_A	
Deceleration Lane Length L_D	175
Freeway Volume, V_F	3916
Ramp Volume, V_R	419
Freeway Free-Flow Speed, S_{FF}	55.0
Ramp Free-Flow Speed, S_{FR}	45.0

Downstream Adj Ramp

☑ Yes ☐ On

☐ No ☑ Off

L_{down} = 885 ft

V_D = 332 veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	v = V/PHF x f_{HV} x f_p
Freeway	3916	0.90	Level	4	0	0.980	1.00	4438
Ramp	419	0.90	Level	10	0	0.952	1.00	489
UpStream								
DownStream	332	0.90	Level	7	0	0.966	1.00	382

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734 v_R + 0.0078 V_{12} - 0.00627 L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 0.436 using Equation (Exhibit 13-7)

V_{12} = 2211 pc/h

V_3 or V_{av34} 1113 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes,V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	4438	Exhibit 13-8	9000	No
$V_{FO} = V_F - V_R$	3949	Exhibit 13-8	9000	No
V_R	489	Exhibit 13-10	2100	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	2211	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086 V_{12} - 0.009 L_D$

D_R = 21.7 (pc/mi/ln)

LOS = C (Exhibit 13-2)

Speed Determination

D_s = 0.342 (Exhibit 13-12)

S_R= 50.6 mph (Exhibit 13-12)

S_0= 59.9 mph (Exhibit 13-12)

S = 54.8 mph (Exhibit 13-13)

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FREEWAY RAMP ADD OR DROP LANE ANALYSIS

ATKINS

General Information

Date Performed:	3/20/2014	Freeway/Direction	US-17 SB
Analysis Year	2013	Junction	Off to Meeting
Analysis Time Period:	AM Peak	Segment ID	6060
Project Description:	Navy Base ICTF		

Inputs

	Freeway Upstream of Ramp	Freeway Downstream of Ramp	Ramp
Number of Lanes, N	4	3	1
Free-Flow Speed, FFS (mph)	55	55	45
Volume, V (veh/h)	3,590	3,132	458
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	3%	2%	7%
%RVs, P_R	0%	0%	0%

Performance Measures

	Freeway Upstream Ramp	Freeway Downstream Ramp	Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.99	0.99	0.97
Demand Flow Rate, v_p (pc/h/ln)	1,012	1,172	527
Capacity Flow Rate, c (pc/h/ln)	2,250	2,250	2,100
v/c ratio	0.45	0.52	0.25
Density, D_{MD} (pc/mi/ln)	17.7	20.5	9.2
LOS	B	C	A

Formulas and Reference Material

$$f_{HV} = \frac{1}{1+P_T(E_T-1)+P_R(E_R-1)}$$ HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P}$$ HCM 2010, Equation 11-2

$$D_{MD} = \frac{0.0175*v_f}{N}$$ HCM 2010, Equation 13-26

Basic Freeway Segments Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
75	2,400
70	2,400
65	2,350
60	2,300
55	2,250

Source: HCM 2010, Exhibit 11-17

Ramp Roadways Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

Diverge LOS Thresholds

LOS	Density (pc/mi/ln)
A	≤10
B	>10-20
C	>20-28
D	>28-35
E	>35
F	v/c > 1

Source: HCM 2010, Exhibit 13-2

FREEWAY RAMP ADD OR DROP LANE ANALYSIS

ATKINS

General Information

Date Performed:	3/20/2014	Freeway/Direction	US-17 SB
Analysis Year	2013	Junction	Off to Meeting
Analysis Time Period:	PM Peak	Segment ID	6060
Project Description:	Navy Base ICTF		

Inputs

	Freeway Upstream of Ramp	Freeway Downstream of Ramp	Ramp
Number of Lanes, N	4	3	1
Free-Flow Speed, FFS (mph)	55	55	45
Volume, V (veh/h)	3,497	3,165	332
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	3%	2%	7%
%RVs, P_R	0%	0%	0%

Performance Measures

	Freeway Upstream Ramp	Freeway Downstream Ramp	Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.99	0.99	0.97
Demand Flow Rate, v_p (pc/h/ln)	986	1,184	382
Capacity Flow Rate, c (pc/h/ln)	2,250	2,250	2,100
v/c ratio	0.44	0.53	0.18
Density, D_{MD} (pc/mi/ln)	17.3	20.7	6.7
LOS	B	C	A

Formulas and Reference Material

$$f_{HV} = \frac{1}{1+P_T(E_T-1)+P_R(E_R-1)}$$ HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P}$$ HCM 2010, Equation 11-2

$$D_{MD} = \frac{0.0175*v_f}{N}$$ HCM 2010, Equation 13-26

Basic Freeway Segments Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
75	2,400
70	2,400
65	2,350
60	2,300
55	2,250

Source: HCM 2010, Exhibit 11-17

Ramp Roadways Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

Diverge LOS Thresholds

LOS	Density (pc/mi/ln)
A	≤10
B	>10-20
C	>20-28
D	>28-35
E	>35
F	v/c > 1

Source: HCM 2010, Exhibit 13-2

FREEWAY RAMP ADD OR DROP LANE ANALYSIS

ATKINS

General Information

Date Performed:	3/20/2014	Freeway/Direction	US-17 SB
Analysis Year	2013	Junction	Off to I-26 WB
Analysis Time Period:	AM Peak	Segment ID	6070
Project Description:	Navy Base ICTF		

Inputs

	Freeway Upstream of Ramp	Freeway Downstream of Ramp	Ramp
Number of Lanes, N	3	2	1
Free-Flow Speed, FFS (mph)	55	55	55
Volume, V (veh/h)	3,132	2,113	1,019
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	2%	2%	2%
%RVs, P_R	0%	0%	0%

Performance Measures

	Freeway Upstream Ramp	Freeway Downstream Ramp	Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.99	0.99	0.99
Demand Flow Rate, v_p (pc/h/ln)	1,172	1,186	1,144
Capacity Flow Rate, c (pc/h/ln)	2,250	2,250	2,200
v/c ratio	0.52	0.53	0.52
Density, D_{MD} (pc/mi/ln)	20.5	20.8	20.0
LOS	C	C	B

Formulas and Reference Material

$$f_{HV} = \frac{1}{1+P_T(E_T-1)+P_R(E_R-1)}$$ HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P}$$ HCM 2010, Equation 11-2

$$D_{MD} = \frac{0.0175*v_f}{N}$$ HCM 2010, Equation 13-26

Basic Freeway Segments Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
75	2,400
70	2,400
65	2,350
60	2,300
55	2,250

Source: HCM 2010, Exhibit 11-17

Ramp Roadways Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

Diverge LOS Thresholds

LOS	Density (pc/mi/ln)
A	≤10
B	>10-20
C	>20-28
D	>28-35
E	>35
F	v/c > 1

Source: HCM 2010, Exhibit 13-2

FREEWAY RAMP ADD OR DROP LANE ANALYSIS

ATKINS

General Information

Date Performed:	3/20/2014	Freeway/Direction	US-17 SB
Analysis Year	2013	Junction	Off to I-26 WB
Analysis Time Period:	PM Peak	Segment ID	6070
Project Description:	Navy Base ICTF		

Inputs

	Freeway Upstream of Ramp	Freeway Downstream of Ramp	Ramp
Number of Lanes, N	3	2	1
Free-Flow Speed, FFS (mph)	55	55	55
Volume, V (veh/h)	3,165	2,143	1,022
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	2%	3%	2%
%RVs, P_R	0%	0%	0%

Performance Measures

	Freeway Upstream Ramp	Freeway Downstream Ramp	Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.99	0.99	0.99
Demand Flow Rate, v_p (pc/h/ln)	1,184	1,208	1,147
Capacity Flow Rate, c (pc/h/ln)	2,250	2,250	2,200
v/c ratio	0.53	0.54	0.52
Density, D_{MD} (pc/mi/ln)	20.7	21.1	20.1
LOS	C	C	C

Formulas and Reference Material

$$f_{HV} = \frac{1}{1+P_T(E_T-1)+P_R(E_R-1)}$$ HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P}$$ HCM 2010, Equation 11-2

$$D_{MD} = \frac{0.0175*v_f}{N}$$ HCM 2010, Equation 13-26

Basic Freeway Segments Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
75	2,400
70	2,400
65	2,350
60	2,300
55	2,250

Source: HCM 2010, Exhibit 11-17

Ramp Roadways Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

Diverge LOS Thresholds

LOS	Density (pc/mi/ln)
A	≤10
B	>10-20
C	>20-28
D	>28-35
E	>35
F	v/c > 1

Source: HCM 2010, Exhibit 13-2

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	146	2307	46	21	2066	53	0	0	41	0	0	13
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	6.0	6.0	6.0	6.0	6.0	6.0			6.0			6.0
Lane Util. Factor	1.00	0.91	1.00	1.00	0.95	1.00			1.00			1.00
Frt	1.00	1.00	0.85	1.00	1.00	0.85			0.86			0.86
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00			1.00			1.00
Satd. Flow (prot)	1770	5085	1583	1770	3539	1583			1611			1611
Flt Permitted	0.95	1.00	1.00	0.95	1.00	1.00			1.00			1.00
Satd. Flow (perm)	1770	5085	1583	1770	3539	1583			1611			1611
Peak-hour factor, PHF	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96
Adj. Flow (vph)	152	2403	48	22	2152	55	0	0	43	0	0	14
RTOR Reduction (vph)	0	0	7	0	0	12	0	0	41	0	0	12
Lane Group Flow (vph)	152	2403	41	22	2152	43	0	0	2	0	0	2
Turn Type	Prot	NA	Perm	Prot	NA	Perm			Over			Over
Protected Phases	5	2		1	6				1			5
Permitted Phases			2			6			1			5
Actuated Green, G (s)	15.7	110.8	110.8	7.2	102.3	102.3			7.2			15.7
Effective Green, g (s)	15.7	110.8	110.8	7.2	102.3	102.3			7.2			15.7
Actuated g/C Ratio	0.12	0.85	0.85	0.06	0.79	0.79			0.06			0.12
Clearance Time (s)	6.0	6.0	6.0	6.0	6.0	6.0			6.0			6.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0			3.0			3.0
Lane Grp Cap (vph)	213	4333	1349	98	2784	1245			89			194
v/s Ratio Prot	c0.09	0.47		0.01	c0.61				0.00			0.00
v/s Ratio Perm			0.03			0.03						
v/c Ratio	0.71	0.55	0.03	0.22	0.77	0.03			0.03			0.01
Uniform Delay, d1	55.0	2.7	1.5	58.7	7.5	3.0			58.1			50.3
Progression Factor	1.00	1.00	1.00	1.11	1.13	0.00			1.00			1.00
Incremental Delay, d2	10.8	0.5	0.0	0.7	1.4	0.0			0.1			0.0
Delay (s)	65.8	3.2	1.5	66.0	9.9	0.0			58.2			50.3
Level of Service	E	A	A	E	A	A			E			D
Approach Delay (s)		6.8			10.2			58.2			50.3	
Approach LOS		A			B			E			D	

Intersection Summary			
HCM 2000 Control Delay	9.0	HCM 2000 Level of Service	A
HCM 2000 Volume to Capacity ratio	0.76		
Actuated Cycle Length (s)	130.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	75.2%	ICU Level of Service	D
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	112	2700	70	30	2002	21	0	0	66	0	0	32
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	6.0	6.0	6.0	6.0	6.0	6.0			6.0			6.0
Lane Util. Factor	1.00	0.91	1.00	1.00	0.95	1.00			1.00			1.00
Frt	1.00	1.00	0.85	1.00	1.00	0.85			0.86			0.86
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00			1.00			1.00
Satd. Flow (prot)	1770	5085	1583	1770	3539	1583			1611			1611
Flt Permitted	0.95	1.00	1.00	0.95	1.00	1.00			1.00			1.00
Satd. Flow (perm)	1770	5085	1583	1770	3539	1583			1611			1611
Peak-hour factor, PHF	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Adj. Flow (vph)	118	2842	74	32	2107	22	0	0	69	0	0	34
RTOR Reduction (vph)	0	0	11	0	0	4	0	0	65	0	0	25
Lane Group Flow (vph)	118	2842	63	32	2107	18	0	0	4	0	0	9
Turn Type	Prot	NA	Perm	Prot	NA	Perm			Over			Over
Protected Phases	5	2		1	6				1			5
Permitted Phases			2			6			1			5
Actuated Green, G (s)	13.6	110.8	110.8	7.2	104.4	104.4			7.2			13.6
Effective Green, g (s)	13.6	110.8	110.8	7.2	104.4	104.4			7.2			13.6
Actuated g/C Ratio	0.10	0.85	0.85	0.06	0.80	0.80			0.06			0.10
Clearance Time (s)	6.0	6.0	6.0	6.0	6.0	6.0			6.0			6.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0			3.0			3.0
Lane Grp Cap (vph)	185	4333	1349	98	2842	1271			89			168
v/s Ratio Prot	c0.07	c0.56		0.02	c0.60				0.00			0.01
v/s Ratio Perm			0.04			0.01						
v/c Ratio	0.64	0.66	0.05	0.33	0.74	0.01			0.04			0.05
Uniform Delay, d1	55.8	3.2	1.5	59.1	6.2	2.5			58.1			52.4
Progression Factor	1.00	1.00	1.00	1.10	1.19	1.00			1.00			1.00
Incremental Delay, d2	7.0	0.8	0.1	1.3	1.2	0.0			0.2			0.1
Delay (s)	62.9	4.0	1.5	66.3	8.6	2.6			58.3			52.5
Level of Service	E	A	A	E	A	A			E			D
Approach Delay (s)		6.2			9.4			58.3			52.5	
Approach LOS		A			A			E			D	

Intersection Summary			
HCM 2000 Control Delay	8.5	HCM 2000 Level of Service	A
HCM 2000 Volume to Capacity ratio	0.74		
Actuated Cycle Length (s)	130.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	72.8%	ICU Level of Service	C
Analysis Period (min)	15		
c Critical Lane Group			

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	337	1799	212	183	1930	80	132	166	109	54	198	78
Number	5	2	12	1	6	16	3	8	18	7	4	14
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1863	1863	1863	1863	1863	1863	1863	1863	1863	1863	1863	1863
Adj Flow Rate, veh/h	347	1855	219	189	1990	82	136	171	112	56	204	80
Adj No. of Lanes	2	3	1	2	3	1	1	2	1	1	2	1
Peak Hour Factor	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97
Percent Heavy Veh, %	2	2	2	2	2	2	2	2	2	2	2	2
Cap, veh/h	399	2837	1007	244	2607	908	267	486	330	266	425	374
Arrive On Green	0.23	1.00	1.00	0.07	0.51	0.51	0.08	0.14	0.14	0.06	0.12	0.12
Sat Flow, veh/h	3442	5085	1583	3442	5085	1583	1774	3539	1583	1774	3539	1583
Grp Volume(v), veh/h	347	1855	219	189	1990	82	136	171	112	56	204	80
Grp Sat Flow(s),veh/h/ln	1721	1695	1583	1721	1695	1583	1774	1770	1583	1774	1770	1583
Q Serve(g_s), s	12.4	0.0	0.0	6.9	40.2	3.0	8.5	5.6	7.7	3.4	6.9	5.2
Cycle Q Clear(g_c), s	12.4	0.0	0.0	6.9	40.2	3.0	8.5	5.6	7.7	3.4	6.9	5.2
Prop In Lane	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Lane Grp Cap(c), veh/h	399	2837	1007	244	2607	908	267	486	330	266	425	374
V/C Ratio(X)	0.87	0.65	0.22	0.78	0.76	0.09	0.51	0.35	0.34	0.21	0.48	0.21
Avail Cap(c_a), veh/h	483	2837	1007	322	2607	908	267	486	330	283	442	381
HCM Platoon Ratio	2.00	2.00	2.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	0.83	0.83	0.83	0.51	0.51	0.51	1.00	1.00	1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	48.3	0.0	0.0	58.6	25.0	12.3	44.9	50.1	43.3	44.5	52.7	39.4
Incr Delay (d2), s/veh	11.6	1.0	0.4	4.4	1.1	0.1	1.6	0.4	0.6	0.4	0.8	0.3
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	6.5	0.3	0.1	3.5	19.1	1.3	4.3	2.8	3.4	1.7	3.4	2.3
LnGrp Delay(d),s/veh	60.0	1.0	0.4	63.0	26.1	12.4	46.5	50.6	43.9	44.9	53.5	39.7
LnGrp LOS	E	A	A	E	C	B	D	D	D	D	D	D
Approach Vol, veh/h		2421			2261			419			340	
Approach Delay, s/veh		9.4			28.7			47.5			48.9	
Approach LOS		A			C			D			D	

Timer	1	2	3	4	5	6	7	8
Assigned Phs	1	2	3	4	5	6	7	8
Phs Duration (G+Y+Rc), s	15.1	77.5	16.0	21.4	20.9	71.7	13.8	23.6
Change Period (Y+Rc), s	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0
Max Green Setting (Gmax), s	12.0	68.0	10.0	16.0	18.0	62.0	9.0	17.0
Max Q Clear Time (g_c+I1), s	8.9	2.0	10.5	8.9	14.4	42.2	5.4	9.7
Green Ext Time (p_c), s	0.2	59.3	0.0	1.1	0.4	19.1	0.0	1.8

Intersection Summary	
HCM 2010 Ctrl Delay	22.8
HCM 2010 LOS	C

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	414	2054	298	290	1686	125	199	262	272	108	222	168
Number	5	2	12	1	6	16	3	8	18	7	4	14
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1863	1863	1863	1863	1863	1863	1863	1863	1863	1863	1863	1863
Adj Flow Rate, veh/h	436	2162	314	305	1775	132	209	276	286	114	234	177
Adj No. of Lanes	2	3	1	2	3	1	1	2	1	1	2	1
Peak Hour Factor	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Percent Heavy Veh, %	2	2	2	2	2	2	2	2	2	2	2	2
Cap, veh/h	483	2494	935	355	2305	828	293	546	408	248	437	418
Arrive On Green	0.28	0.98	0.98	0.10	0.45	0.45	0.10	0.15	0.15	0.07	0.12	0.12
Sat Flow, veh/h	3442	5085	1583	3442	5085	1583	1774	3539	1583	1774	3539	1583
Grp Volume(v), veh/h	436	2162	314	305	1775	132	209	276	286	114	234	177
Grp Sat Flow(s),veh/h/ln	1721	1695	1583	1721	1695	1583	1774	1770	1583	1774	1770	1583
Q Serve(g_s), s	15.8	7.0	0.7	11.3	38.0	5.6	13.0	9.3	20.0	7.2	8.0	12.0
Cycle Q Clear(g_c), s	15.8	7.0	0.7	11.3	38.0	5.6	13.0	9.3	20.0	7.2	8.0	12.0
Prop In Lane	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Lane Grp Cap(c), veh/h	483	2494	935	355	2305	828	293	546	408	248	437	418
V/C Ratio(X)	0.90	0.87	0.34	0.86	0.77	0.16	0.71	0.51	0.70	0.46	0.54	0.42
Avail Cap(c_a), veh/h	531	2494	935	372	2305	828	293	546	408	248	437	418
HCM Platoon Ratio	2.00	2.00	2.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	0.73	0.73	0.73	0.56	0.56	0.56	1.00	1.00	1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	45.8	0.7	0.4	57.2	29.8	16.1	44.9	50.3	43.6	45.3	53.4	39.6
Incr Delay (d2), s/veh	13.8	3.3	0.7	10.7	1.5	0.2	8.0	0.8	5.3	1.3	1.3	0.7
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	8.3	1.6	0.4	5.9	18.1	2.5	1.4	4.6	9.9	3.6	4.0	5.3
LnGrp Delay(d),s/veh	59.6	3.9	1.1	67.9	31.2	16.3	52.9	51.1	49.0	46.6	54.7	40.3
LnGrp LOS	E	A	A	E	C	B	D	D	D	D	D	D
Approach Vol, veh/h		2912			2212			771			525	
Approach Delay, s/veh		12.0			35.4			50.8			48.1	
Approach LOS		B			D			D			D	

Timer	1	2	3	4	5	6	7	8
Assigned Phs	1	2	3	4	5	6	7	8
Phs Duration (G+Y+Rc), s	19.4	69.6	19.0	22.0	24.2	64.8	15.0	26.0
Change Period (Y+Rc), s	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0
Max Green Setting (Gmax), s	14.0	63.0	13.0	16.0	20.0	57.0	9.0	20.0
Max Q Clear Time (g_c+I1), s	13.3	9.0	15.0	14.0	17.8	40.0	9.2	22.0
Green Ext Time (p_c), s	0.1	50.4	0.0	1.0	0.4	16.6	0.0	0.0

Intersection Summary	
HCM 2010 Ctrl Delay	27.7
HCM 2010 LOS	C

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	202	1662	98	127	1986	254	65	149	113	164	154	142
Number	5	2	12	1	6	16	3	8	18	7	4	14
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1845	1845	1845	1863	1863	1863	1863	1863	1863	1863	1863	1863
Adj Flow Rate, veh/h	220	1807	107	138	2159	276	71	162	123	178	167	154
Adj No. of Lanes	1	3	1	1	3	1	1	1	1	2	1	1
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Percent Heavy Veh, %	3	3	3	2	2	2	2	2	2	2	2	2
Cap, veh/h	246	2849	988	255	2734	962	115	227	304	241	238	357
Arrive On Green	0.10	0.57	0.57	0.02	0.18	0.18	0.06	0.12	0.12	0.07	0.13	0.13
Sat Flow, veh/h	1757	5036	1568	1774	5085	1583	1774	1863	1583	3442	1863	1583
Grp Volume(v), veh/h	220	1807	107	138	2159	276	71	162	123	178	167	154
Grp Sat Flow(s),veh/h/ln	1757	1679	1568	1774	1695	1583	1774	1863	1583	1721	1863	1583
Q Serve(g_s), s	10.3	31.1	3.5	4.2	52.0	16.5	5.0	10.7	8.7	6.5	11.0	10.7
Cycle Q Clear(g_c), s	10.3	31.1	3.5	4.2	52.0	16.5	5.0	10.7	8.7	6.5	11.0	10.7
Prop In Lane	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Lane Grp Cap(c), veh/h	246	2849	988	255	2734	962	115	227	304	241	238	357
V/C Ratio(X)	0.89	0.63	0.11	0.54	0.79	0.29	0.62	0.71	0.41	0.74	0.70	0.43
Avail Cap(c_a), veh/h	294	2849	988	325	2734	962	125	233	308	242	238	357
HCM Platoon Ratio	1.00	1.00	1.00	0.33	0.33	0.33	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	0.71	0.71	0.71	0.78	0.78	0.78	1.00	1.00	1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	38.6	18.8	9.4	19.4	45.8	23.3	58.4	54.1	45.4	58.4	53.5	42.6
Incr Delay (d2), s/veh	18.9	0.8	0.2	1.4	1.9	0.6	7.9	9.6	0.9	11.2	9.0	0.8
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	8.9	14.6	1.5	2.8	25.0	7.4	2.7	6.1	3.9	3.5	6.3	4.8
LnGrp Delay(d),s/veh	57.5	19.6	9.5	20.8	47.6	23.9	66.3	63.6	46.2	69.6	62.5	43.4
LnGrp LOS	E	B	A	C	D	C	E	E	D	E	E	D
Approach Vol, veh/h		2134			2573			356			499	
Approach Delay, s/veh		23.0			43.7			58.2			59.1	
Approach LOS		C			D			E			E	

Timer	1	2	3	4	5	6	7	8
Assigned Phs	1	2	3	4	5	6	7	8
Phs Duration (G+Y+Rc), s	14.9	78.5	14.3	22.3	18.5	74.9	15.0	21.6
Change Period (Y+Rc), s	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0
Max Green Setting (Gmax), s	14.0	67.0	9.0	16.0	16.0	65.0	9.0	16.0
Max Q Clear Time (g_c+I1), s	6.2	33.1	7.0	13.0	12.3	54.0	8.5	12.7
Green Ext Time (p_c), s	0.2	32.4	0.0	0.9	0.2	10.8	0.0	0.6

Intersection Summary	
HCM 2010 Ctrl Delay	38.1
HCM 2010 LOS	D

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	224	2111	99	192	1828	140	86	163	226	178	199	187
Number	5	2	12	1	6	16	3	8	18	7	4	14
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1863	1863	1863	1863	1863	1863	1863	1863	1863	1863	1863	1863
Adj Flow Rate, veh/h	241	2270	106	206	1966	151	92	175	243	191	214	201
Adj No. of Lanes	1	3	1	1	3	1	1	1	1	2	1	1
Peak Hour Factor	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93
Percent Heavy Veh, %	2	2	2	2	2	2	2	2	2	2	2	2
Cap, veh/h	268	2622	923	234	2544	903	119	275	376	240	280	404
Arrive On Green	0.11	0.52	0.52	0.03	0.17	0.17	0.07	0.15	0.15	0.07	0.15	0.15
Sat Flow, veh/h	1774	5085	1583	1774	5085	1583	1774	1863	1583	3442	1863	1583
Grp Volume(v), veh/h	241	2270	106	206	1966	151	92	175	243	191	214	201
Grp Sat Flow(s),veh/h/ln	1774	1695	1583	1774	1695	1583	1774	1863	1583	1721	1863	1583
Q Serve(g_s), s	11.3	50.3	3.9	9.5	47.7	9.1	6.6	11.4	17.8	7.0	14.2	13.9
Cycle Q Clear(g_c), s	11.3	50.3	3.9	9.5	47.7	9.1	6.6	11.4	17.8	7.0	14.2	13.9
Prop In Lane	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Lane Grp Cap(c), veh/h	268	2622	923	234	2544	903	119	275	376	240	280	404
V/C Ratio(X)	0.90	0.87	0.11	0.88	0.77	0.17	0.77	0.64	0.65	0.79	0.77	0.50
Avail Cap(c_a), veh/h	315	2622	923	267	2544	903	124	275	376	240	280	404
HCM Platoon Ratio	1.00	1.00	1.00	0.33	0.33	0.33	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	0.47	0.47	0.47	0.84	0.84	0.84	1.00	1.00	1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	36.8	27.3	12.0	40.0	46.8	23.1	59.1	51.7	44.2	59.0	52.6	40.9
Incr Delay (d2), s/veh	13.9	2.0	0.1	21.6	2.0	0.3	24.4	4.8	3.8	16.6	11.9	0.9
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	9.5	24.0	1.7	8.7	22.9	4.1	4.0	6.2	8.2	3.9	8.2	6.2
LnGrp Delay(d),s/veh	50.8	29.3	12.1	61.5	48.7	23.5	83.5	56.5	48.0	75.6	64.5	41.9
LnGrp LOS	D	C	B	E	D	C	F	E	D	E	E	D
Approach Vol, veh/h		2617			2323			510			606	
Approach Delay, s/veh		30.6			48.2			57.3			60.5	
Approach LOS		C			D			E			E	

Timer	1	2	3	4	5	6	7	8
Assigned Phs	1	2	3	4	5	6	7	8
Phs Duration (G+Y+Rc), s	17.6	72.4	14.7	25.3	19.6	70.4	15.0	25.0
Change Period (Y+Rc), s	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0
Max Green Setting (Gmax), s	14.0	64.0	9.0	19.0	17.0	61.0	9.0	19.0
Max Q Clear Time (g_c+I1), s	11.5	52.3	8.6	16.2	13.3	49.7	9.0	19.8
Green Ext Time (p_c), s	0.1	11.5	0.0	1.2	0.2	11.2	0.0	0.0

Intersection Summary	
HCM 2010 Ctrl Delay	42.6
HCM 2010 LOS	D

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Volume (veh/h)	1858	81	85	2307	60	79
Number	2	12	1	6	3	18
Initial Q (Qb), veh	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)		1.00	1.00		1.00	1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1845	1845	1863	1863	1863	1863
Adj Flow Rate, veh/h	1998	87	91	2481	65	85
Adj No. of Lanes	3	1	1	3	1	1
Peak Hour Factor	0.93	0.93	0.93	0.93	0.93	0.93
Percent Heavy Veh, %	3	3	2	2	2	2
Cap, veh/h	3729	1271	320	4350	125	219
Arrive On Green	0.98	0.98	0.14	1.00	0.07	0.07
Sat Flow, veh/h	5202	1568	1774	5253	1774	1583
Grp Volume(v), veh/h	1998	87	91	2481	65	85
Grp Sat Flow(s),veh/h/ln	1679	1568	1774	1695	1774	1583
Q Serve(g_s), s	1.6	0.1	1.2	0.0	4.5	6.2
Cycle Q Clear(g_c), s	1.6	0.1	1.2	0.0	4.5	6.2
Prop In Lane		1.00	1.00		1.00	1.00
Lane Grp Cap(c), veh/h	3729	1271	320	4350	125	219
V/C Ratio(X)	0.54	0.07	0.28	0.57	0.52	0.39
Avail Cap(c_a), veh/h	3729	1271	381	4350	195	281
HCM Platoon Ratio	1.33	1.33	2.00	2.00	1.00	1.00
Upstream Filter(I)	0.71	0.71	0.35	0.35	1.00	1.00
Uniform Delay (d), s/veh	0.3	0.1	2.0	0.0	57.2	50.0
Incr Delay (d2), s/veh	0.4	0.1	0.2	0.2	3.3	1.1
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	0.5	0.1	0.5	0.1	2.3	2.8
LnGrp Delay(d),s/veh	0.7	0.2	2.2	0.2	60.5	51.2
LnGrp LOS	A	A	A	A	E	D
Approach Vol, veh/h	2085			2572	150	
Approach Delay, s/veh	0.6			0.3	55.2	
Approach LOS	A			A	E	

Timer	1	2	3	4	5	6	7	8
Assigned Phs	1	2				6		8
Phs Duration (G+Y+Rc), s	14.6	100.4				115.0		15.0
Change Period (Y+Rc), s	6.0	6.0				6.0		6.0
Max Green Setting (Gmax), s	13.0	85.0				104.0		14.0
Max Q Clear Time (g_c+I1), s	3.2	3.6				2.0		8.2
Green Ext Time (p_c), s	0.1	76.8				94.9		0.2

Intersection Summary	
HCM 2010 Ctrl Delay	2.1
HCM 2010 LOS	A

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Volume (veh/h)	2419	96	121	2096	64	145
Number	2	12	1	6	3	18
Initial Q (Qb), veh	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)		1.00	1.00		1.00	1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1863	1863	1863	1863	1863	1863
Adj Flow Rate, veh/h	2573	102	129	2230	68	154
Adj No. of Lanes	3	1	1	3	1	1
Peak Hour Factor	0.94	0.94	0.94	0.94	0.94	0.94
Percent Heavy Veh, %	2	2	2	2	2	2
Cap, veh/h	3641	1256	256	4225	136	230
Arrive On Green	1.00	1.00	0.14	1.00	0.08	0.08
Sat Flow, veh/h	5253	1583	1774	5253	1774	1583
Grp Volume(v), veh/h	2573	102	129	2230	68	154
Grp Sat Flow(s),veh/h/ln	1695	1583	1774	1695	1774	1583
Q Serve(g_s), s	0.0	0.0	2.0	0.0	4.8	10.0
Cycle Q Clear(g_c), s	0.0	0.0	2.0	0.0	4.8	10.0
Prop In Lane		1.00	1.00		1.00	1.00
Lane Grp Cap(c), veh/h	3641	1256	256	4225	136	230
V/C Ratio(X)	0.71	0.08	0.50	0.53	0.50	0.67
Avail Cap(c_a), veh/h	3641	1256	339	4225	136	230
HCM Platoon Ratio	2.00	2.00	2.00	2.00	1.00	1.00
Upstream Filter(I)	0.42	0.42	0.48	0.48	1.00	1.00
Uniform Delay (d), s/veh	0.0	0.0	6.5	0.0	57.6	52.6
Incr Delay (d2), s/veh	0.5	0.1	0.7	0.2	2.8	7.2
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	0.2	0.0	3.2	0.1	2.4	5.7
LnGrp Delay(d),s/veh	0.5	0.1	7.2	0.2	60.4	59.8
LnGrp LOS	A	A	A	A	E	E
Approach Vol, veh/h	2675			2359	222	
Approach Delay, s/veh	0.5			0.6	60.0	
Approach LOS	A			A	E	

Timer	1	2	3	4	5	6	7	8
Assigned Phs	1	2				6		8
Phs Duration (G+Y+Rc), s	14.9	99.1				114.0		16.0
Change Period (Y+Rc), s	6.0	6.0				6.0		6.0
Max Green Setting (Gmax), s	15.0	87.0				108.0		10.0
Max Q Clear Time (g_c+I1), s	4.0	2.0				2.0		12.0
Green Ext Time (p_c), s	0.2	82.0				101.3		0.0

Intersection Summary	
HCM 2010 Ctrl Delay	3.1
HCM 2010 LOS	A

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	157	1706	74	118	2200	236	88	43	95	133	54	104
Number	5	2	12	1	6	16	3	8	18	7	4	14
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1845	1845	1845	1863	1863	1863	1863	1863	1863	1863	1863	1863
Adj Flow Rate, veh/h	165	1796	78	124	2316	248	93	45	100	140	57	109
Adj No. of Lanes	1	3	1	1	3	1	2	1	1	2	1	1
Peak Hour Factor	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Percent Heavy Veh, %	3	3	3	2	2	2	2	2	2	2	2	2
Cap, veh/h	188	2532	982	299	2554	991	438	230	304	438	230	305
Arrive On Green	0.14	1.00	1.00	0.07	0.50	0.50	0.12	0.12	0.12	0.12	0.12	0.12
Sat Flow, veh/h	1757	5036	1568	1774	5085	1583	3548	1863	1583	3548	1863	1583
Grp Volume(v), veh/h	165	1796	78	124	2316	248	93	45	100	140	57	109
Grp Sat Flow(s),veh/h/ln	1757	1679	1568	1774	1695	1583	1774	1863	1583	1774	1863	1583
Q Serve(g_s), s	6.9	0.0	0.0	4.2	53.9	9.0	3.1	2.8	7.1	4.7	3.6	7.7
Cycle Q Clear(g_c), s	6.9	0.0	0.0	4.2	53.9	9.0	3.1	2.8	7.1	4.7	3.6	7.7
Prop In Lane	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Lane Grp Cap(c), veh/h	188	2532	982	299	2554	991	438	230	304	438	230	305
V/C Ratio(X)	0.88	0.71	0.08	0.41	0.91	0.25	0.21	0.20	0.33	0.32	0.25	0.36
Avail Cap(c_a), veh/h	202	2532	982	342	2554	991	438	230	304	438	230	305
HCM Platoon Ratio	2.00	2.00	2.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	0.82	0.82	0.82	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	30.9	0.0	0.0	12.8	29.5	10.8	51.1	51.0	45.1	51.8	51.3	45.3
Incr Delay (d2), s/veh	27.1	1.4	0.1	0.9	6.0	0.6	0.2	0.4	0.6	0.4	0.6	0.7
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	7.1	0.3	0.0	2.1	26.5	5.4	1.5	1.5	3.1	2.3	1.9	3.4
LnGrp Delay(d),s/veh	58.0	1.4	0.1	13.7	35.5	11.4	51.3	51.4	45.7	52.2	51.9	46.0
LnGrp LOS	E	A	A	B	D	B	D	D	D	D	D	D
Approach Vol, veh/h		2039			2688			238			306	
Approach Delay, s/veh		5.9			32.2			49.0			49.9	
Approach LOS		A			C			D			D	

Timer	1	2	3	4	5	6	7	8
Assigned Phs	1	2		4	5	6		8
Phs Duration (G+Y+Rc), s	14.9	71.1		22.0	15.0	71.0		22.0
Change Period (Y+Rc), s	6.0	6.0		6.0	6.0	6.0		6.0
Max Green Setting (Gmax), s	12.0	62.0		16.0	10.0	64.0		16.0
Max Q Clear Time (g_c+I1), s	6.2	2.0		9.7	8.9	55.9		9.1
Green Ext Time (p_c), s	0.1	56.3		0.6	0.0	8.0		0.5

Intersection Summary	
HCM 2010 Ctrl Delay	23.8
HCM 2010 LOS	C

Notes

User approved volume balancing among the lanes for turning movement.

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	207	2246	111	188	1935	262	110	93	182	313	168	172
Number	5	2	12	1	6	16	3	8	18	7	4	14
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1863	1863	1863	1863	1863	1863	1863	1863	1863	1863	1863	1863
Adj Flow Rate, veh/h	216	2340	116	196	2016	273	118	93	190	326	175	179
Adj No. of Lanes	1	3	1	1	3	1	2	1	1	2	1	1
Peak Hour Factor	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96
Percent Heavy Veh, %	2	2	2	2	2	2	2	2	2	2	2	2
Cap, veh/h	239	2551	990	249	2456	961	440	231	309	440	231	339
Arrive On Green	0.18	1.00	1.00	0.07	0.48	0.48	0.12	0.12	0.12	0.12	0.12	0.12
Sat Flow, veh/h	1774	5085	1583	1774	5085	1583	3548	1863	1583	3548	1863	1583
Grp Volume(v), veh/h	216	2340	116	196	2016	273	118	93	190	326	175	179
Grp Sat Flow(s),veh/h/ln	1774	1695	1583	1774	1695	1583	1774	1863	1583	1774	1863	1583
Q Serve(g_s), s	9.4	0.0	0.0	7.1	43.8	10.6	3.9	5.9	14.2	11.4	11.7	12.9
Cycle Q Clear(g_c), s	9.4	0.0	0.0	7.1	43.8	10.6	3.9	5.9	14.2	11.4	11.7	12.9
Prop In Lane	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Lane Grp Cap(c), veh/h	239	2551	990	249	2456	961	440	231	309	440	231	339
V/C Ratio(X)	0.90	0.92	0.12	0.79	0.82	0.28	0.27	0.40	0.61	0.74	0.76	0.53
Avail Cap(c_a), veh/h	285	2551	990	273	2456	961	440	231	309	440	231	339
HCM Platoon Ratio	2.00	2.00	2.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	0.64	0.64	0.64	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	29.2	0.0	0.0	19.0	28.6	12.0	51.3	52.2	47.5	54.6	54.7	45.0
Incr Delay (d2), s/veh	19.5	4.5	0.2	13.2	3.2	0.7	0.3	1.1	3.6	6.6	13.5	1.5
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	8.7	1.1	0.0	4.3	21.3	6.3	1.9	3.1	6.5	6.0	6.9	5.8
LnGrp Delay(d),s/veh	48.7	4.5	0.2	32.2	31.8	12.8	51.6	53.3	51.1	61.2	68.2	46.5
LnGrp LOS	D	A	A	C	C	B	D	D	D	E	E	D
Approach Vol, veh/h		2672			2485			401			680	
Approach Delay, s/veh		7.8			29.8			51.7			59.1	
Approach LOS		A			C			D			E	

Timer	1	2	3	4	5	6	7	8
Assigned Phs	1	2		4	5	6		8
Phs Duration (G+Y+Rc), s	15.2	70.8		22.0	17.6	68.4		22.0
Change Period (Y+Rc), s	6.0	6.0		6.0	6.0	6.0		6.0
Max Green Setting (Gmax), s	11.0	63.0		16.0	15.0	59.0		16.0
Max Q Clear Time (g_c+I1), s	9.1	2.0		14.9	11.4	45.8		16.2
Green Ext Time (p_c), s	0.1	58.4		0.4	0.2	13.0		0.0

Intersection Summary	
HCM 2010 Ctrl Delay	25.0
HCM 2010 LOS	C

Notes

User approved volume balancing among the lanes for turning movement.

Appendix E
Traffic Analysis Worksheets

2013 Existing

North Charleston Intersections

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	0	0	0	0	137	0	0	0	0	0	1365	380
Number				7	4	14				5	2	12
Initial Q (Qb), veh				0	0	0				0	0	0
Ped-Bike Adj(A_pbT)				1.00		1.00				1.00		1.00
Parking Bus, Adj				1.00	1.00	1.00				1.00	1.00	1.00
Adj Sat Flow, veh/h/ln				0	1759	0				0	1827	1827
Adj Flow Rate, veh/h				0	171	0				0	1706	475
Adj No. of Lanes				0	2	0				0	3	1
Peak Hour Factor				0.80	0.80	0.80				0.80	0.80	0.80
Percent Heavy Veh, %				0	8	0				0	4	4
Cap, veh/h				0	556	0				0	2932	913
Arrive On Green				0.00	0.17	0.00				0.00	0.59	0.59
Sat Flow, veh/h				0	3519	0				0	5152	1553
Grp Volume(v), veh/h				0	171	0				0	1706	475
Grp Sat Flow(s),veh/h/ln				0	1671	0				0	1663	1553
Q Serve(g_s), s				0.0	2.2	0.0				0.0	10.5	8.9
Cycle Q Clear(g_c), s				0.0	2.2	0.0				0.0	10.5	8.9
Prop In Lane				0.00		0.00				0.00		1.00
Lane Grp Cap(c), veh/h				0	556	0				0	2932	913
V/C Ratio(X)				0.00	0.31	0.00				0.00	0.58	0.52
Avail Cap(c_a), veh/h				0	1301	0				0	3984	1241
HCM Platoon Ratio				1.00	1.00	1.00				1.00	1.00	1.00
Upstream Filter(I)				0.00	1.00	0.00				0.00	1.00	1.00
Uniform Delay (d), s/veh				0.0	17.9	0.0				0.0	6.3	6.0
Incr Delay (d2), s/veh				0.0	0.3	0.0				0.0	0.2	0.5
Initial Q Delay(d3),s/veh				0.0	0.0	0.0				0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln				0.0	1.0	0.0				0.0	4.8	3.8
LnGrp Delay(d),s/veh				0.0	18.2	0.0				0.0	6.5	6.4
LnGrp LOS					B						A	A
Approach Vol, veh/h					171						2181	
Approach Delay, s/veh					18.2						6.5	
Approach LOS					B						A	

Timer	1	2	3	4	5	6	7	8
Assigned Phs		2		4				
Phs Duration (G+Y+Rc), s		34.7		14.1				
Change Period (Y+Rc), s		6.0		6.0				
Max Green Setting (Gmax), s		39.0		19.0				
Max Q Clear Time (g_c+I1), s		12.5		4.2				
Green Ext Time (p_c), s		16.2		0.8				

Intersection Summary	
HCM 2010 Ctrl Delay	7.3
HCM 2010 LOS	A

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	0	0	0	0	213	0	0	0	0	0	913	274
Number				7	4	14				5	2	12
Initial Q (Qb), veh				0	0	0				0	0	0
Ped-Bike Adj(A_pbT)				1.00		1.00				1.00		1.00
Parking Bus, Adj				1.00	1.00	1.00				1.00	1.00	1.00
Adj Sat Flow, veh/h/ln				0	1845	0				0	1863	1863
Adj Flow Rate, veh/h				0	232	0				0	992	298
Adj No. of Lanes				0	2	0				0	3	1
Peak Hour Factor				0.92	0.92	0.92				0.92	0.92	0.92
Percent Heavy Veh, %				0	3	0				0	2	2
Cap, veh/h				0	312	0				0	4797	1493
Arrive On Green				0.00	0.09	0.00				0.00	0.94	0.94
Sat Flow, veh/h				0	3689	0				0	5253	1583
Grp Volume(v), veh/h				0	232	0				0	992	298
Grp Sat Flow(s),veh/h/ln				0	1752	0				0	1695	1583
Q Serve(g_s), s				0.0	9.3	0.0				0.0	2.0	1.9
Cycle Q Clear(g_c), s				0.0	9.3	0.0				0.0	2.0	1.9
Prop In Lane				0.00		0.00				0.00		1.00
Lane Grp Cap(c), veh/h				0	312	0				0	4797	1493
V/C Ratio(X)				0.00	0.74	0.00				0.00	0.21	0.20
Avail Cap(c_a), veh/h				0	1124	0				0	4797	1493
HCM Platoon Ratio				1.00	1.00	1.00				1.00	1.00	1.00
Upstream Filter(I)				0.00	1.00	0.00				0.00	1.00	1.00
Uniform Delay (d), s/veh				0.0	63.7	0.0				0.0	0.3	0.3
Incr Delay (d2), s/veh				0.0	3.5	0.0				0.0	0.1	0.3
Initial Q Delay(d3),s/veh				0.0	0.0	0.0				0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln				0.0	4.6	0.0				0.0	0.9	0.9
LnGrp Delay(d),s/veh				0.0	67.2	0.0				0.0	0.4	0.6
LnGrp LOS					E						A	A
Approach Vol, veh/h					232						1290	
Approach Delay, s/veh					67.2						0.4	
Approach LOS					E						A	

Timer	1	2	3	4	5	6	7	8
Assigned Phs		2		4				
Phs Duration (G+Y+Rc), s		141.2		18.8				
Change Period (Y+Rc), s		6.0		6.0				
Max Green Setting (Gmax), s		102.0		46.0				
Max Q Clear Time (g_c+I1), s		4.0		11.3				
Green Ext Time (p_c), s		9.6		1.5				

Intersection Summary	
HCM 2010 Ctrl Delay	10.6
HCM 2010 LOS	B

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	0	372	0	0	0	0	0	542	93	0	0	0
Number	3	8	18				1	6	16			
Initial Q (Qb), veh	0	0	0				0	0	0			
Ped-Bike Adj(A_pbT)	1.00		1.00				1.00		1.00			
Parking Bus, Adj	1.00	1.00	1.00				1.00	1.00	1.00			
Adj Sat Flow, veh/h/ln	0	1827	0				0	1759	1759			
Adj Flow Rate, veh/h	0	465	0				0	678	116			
Adj No. of Lanes	0	2	0				0	3	1			
Peak Hour Factor	0.80	0.80	0.80				0.80	0.80	0.80			
Percent Heavy Veh, %	0	4	0				0	8	8			
Cap, veh/h	0	839	0				0	2081	648			
Arrive On Green	0.00	0.24	0.00				0.00	0.43	0.43			
Sat Flow, veh/h	0	3654	0				0	4961	1495			
Grp Volume(v), veh/h	0	465	0				0	678	116			
Grp Sat Flow(s),veh/h/ln	0	1736	0				0	1601	1495			
Q Serve(g_s), s	0.0	4.3	0.0				0.0	3.4	1.8			
Cycle Q Clear(g_c), s	0.0	4.3	0.0				0.0	3.4	1.8			
Prop In Lane	0.00		0.00				0.00		1.00			
Lane Grp Cap(c), veh/h	0	839	0				0	2081	648			
V/C Ratio(X)	0.00	0.55	0.00				0.00	0.33	0.18			
Avail Cap(c_a), veh/h	0	1786	0				0	5073	1579			
HCM Platoon Ratio	1.00	1.00	1.00				1.00	1.00	1.00			
Upstream Filter(I)	0.00	1.00	0.00				0.00	1.00	1.00			
Uniform Delay (d), s/veh	0.0	12.3	0.0				0.0	6.9	6.4			
Incr Delay (d2), s/veh	0.0	0.6	0.0				0.0	0.1	0.1			
Initial Q Delay(d3),s/veh	0.0	0.0	0.0				0.0	0.0	0.0			
%ile BackOfQ(50%),veh/ln	0.0	2.1	0.0				0.0	1.5	0.7			
LnGrp Delay(d),s/veh	0.0	12.8	0.0				0.0	7.0	6.6			
LnGrp LOS		B						A	A			
Approach Vol, veh/h		465						794				
Approach Delay, s/veh		12.8						6.9				
Approach LOS		B						A				

Timer	1	2	3	4	5	6	7	8
Assigned Phs						6		8
Phs Duration (G+Y+Rc), s						22.0		14.9
Change Period (Y+Rc), s						6.0		6.0
Max Green Setting (Gmax), s						39.0		19.0
Max Q Clear Time (g_c+I1), s						5.4		6.3
Green Ext Time (p_c), s						5.1		2.4

Intersection Summary	
HCM 2010 Ctrl Delay	9.1
HCM 2010 LOS	A

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	0	245	0	0	0	0	0	1411	175	0	0	0
Number	3	8	18				1	6	16			
Initial Q (Qb), veh	0	0	0				0	0	0			
Ped-Bike Adj(A_pbT)	1.00		1.00				1.00		1.00			
Parking Bus, Adj	1.00	1.00	1.00				1.00	1.00	1.00			
Adj Sat Flow, veh/h/ln	0	1863	0				0	1845	1845			
Adj Flow Rate, veh/h	0	275	0				0	1585	197			
Adj No. of Lanes	0	2	0				0	3	1			
Peak Hour Factor	0.89	0.89	0.89				0.89	0.89	0.89			
Percent Heavy Veh, %	0	2	0				0	3	3			
Cap, veh/h	0	363	0				0	4079	1270			
Arrive On Green	0.00	0.10	0.00				0.00	0.81	0.81			
Sat Flow, veh/h	0	3725	0				0	5202	1568			
Grp Volume(v), veh/h	0	275	0				0	1585	197			
Grp Sat Flow(s),veh/h/ln	0	1770	0				0	1679	1568			
Q Serve(g_s), s	0.0	10.4	0.0				0.0	12.0	3.7			
Cycle Q Clear(g_c), s	0.0	10.4	0.0				0.0	12.0	3.7			
Prop In Lane	0.00		0.00				0.00		1.00			
Lane Grp Cap(c), veh/h	0	363	0				0	4079	1270			
V/C Ratio(X)	0.00	0.76	0.00				0.00	0.39	0.16			
Avail Cap(c_a), veh/h	0	956	0				0	4079	1270			
HCM Platoon Ratio	1.00	1.00	1.00				1.00	1.00	1.00			
Upstream Filter(I)	0.00	1.00	0.00				0.00	1.00	1.00			
Uniform Delay (d), s/veh	0.0	59.8	0.0				0.0	3.6	2.8			
Incr Delay (d2), s/veh	0.0	3.3	0.0				0.0	0.3	0.3			
Initial Q Delay(d3),s/veh	0.0	0.0	0.0				0.0	0.0	0.0			
%ile BackOfQ(50%),veh/ln	0.0	5.2	0.0				0.0	5.5	1.7			
LnGrp Delay(d),s/veh	0.0	63.1	0.0				0.0	3.9	3.1			
LnGrp LOS		E						A	A			
Approach Vol, veh/h		275						1782				
Approach Delay, s/veh		63.1						3.8				
Approach LOS		E						A				

Timer	1	2	3	4	5	6	7	8
Assigned Phs						6		8
Phs Duration (G+Y+Rc), s						117.0		20.0
Change Period (Y+Rc), s						6.0		6.0
Max Green Setting (Gmax), s						111.0		37.0
Max Q Clear Time (g_c+I1), s						14.0		12.4
Green Ext Time (p_c), s						19.3		1.7

Intersection Summary	
HCM 2010 Ctrl Delay	11.7
HCM 2010 LOS	B

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	0	61	44	0	0	0	40	0	0	0	936	418
Number	7	4	14	3	8	18	1	6	16	5	2	12
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	0	1792	1792	0	1863	0	1712	0	0	0	1810	1810
Adj Flow Rate, veh/h	0	62	45	0	0	0	41	0	0	0	955	427
Adj No. of Lanes	0	1	1	0	1	0	1	0	0	0	3	1
Peak Hour Factor	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98
Percent Heavy Veh, %	0	6	6	0	2	0	11	0	0	0	5	5
Cap, veh/h	0	212	180	0	220	0	118	0	0	0	2998	934
Arrive On Green	0.00	0.12	0.12	0.00	0.00	0.00	0.07	0.00	0.00	0.00	0.61	0.61
Sat Flow, veh/h	0	1792	1524	0	1863	0	1630	41		0	5103	1538
Grp Volume(v), veh/h	0	62	45	0	0	0	41	30.5		0	955	427
Grp Sat Flow(s),veh/h/ln	0	1792	1524	0	1863	0	1630	C		0	1647	1538
Q Serve(g_s), s	0.0	2.1	1.8	0.0	0.0	0.0	1.6			0.0	6.1	9.9
Cycle Q Clear(g_c), s	0.0	2.1	1.8	0.0	0.0	0.0	1.6			0.0	6.1	9.9
Prop In Lane	0.00		1.00	0.00		0.00	1.00			0.00		1.00
Lane Grp Cap(c), veh/h	0	212	180	0	220	0	118			0	2998	934
V/C Ratio(X)	0.00	0.29	0.25	0.00	0.00	0.00	0.35			0.00	0.32	0.46
Avail Cap(c_a), veh/h	0	302	257	0	314	0	275			0	2998	934
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00			1.00	1.00	1.00
Upstream Filter(I)	0.00	1.00	1.00	0.00	0.00	0.00	1.00			0.00	1.00	1.00
Uniform Delay (d), s/veh	0.0	26.3	26.1	0.0	0.0	0.0	28.8			0.0	6.2	7.0
Incr Delay (d2), s/veh	0.0	0.8	0.7	0.0	0.0	0.0	1.7			0.0	0.3	1.6
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0			0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	0.0	1.1	0.8	0.0	0.0	0.0	0.8			0.0	2.8	4.6
LnGrp Delay(d),s/veh	0.0	27.0	26.8	0.0	0.0	0.0	30.5			0.0	6.5	8.6
LnGrp LOS		C	C				C				A	A
Approach Vol, veh/h		107			0						1382	
Approach Delay, s/veh		26.9			0.0						7.2	
Approach LOS		C									A	

Timer	1	2	3	4	5	6	7	8
Assigned Phs	1	2		4				8
Phs Duration (G+Y+Rc), s	10.7	45.6		13.7				13.7
Change Period (Y+Rc), s	6.0	6.0		6.0				6.0
Max Green Setting (Gmax), s	11.0	30.0		11.0				11.0
Max Q Clear Time (g_c+I1), s	3.6	11.9		5.1				0.0
Green Ext Time (p_c), s	0.0	7.5		0.2				0.0

Intersection Summary	
HCM 2010 Ctrl Delay	9.2
HCM 2010 LOS	A

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	0	251	58	0	0	0	51	0	0	0	721	162
Number	7	4	14	3	8	18	1	6	16	5	2	12
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	0	1863	1863	0	1863	0	1845	0	0	0	1792	1792
Adj Flow Rate, veh/h	0	273	63	0	0	0	55	0	0	0	784	176
Adj No. of Lanes	0	1	1	0	1	0	1	0	0	0	3	1
Peak Hour Factor	0.92	0.92	0.92	0.90	0.90	0.90	0.92	0.92	0.92	0.92	0.92	0.92
Percent Heavy Veh, %	0	2	2	0	2	0	3	0	0	0	6	6
Cap, veh/h	0	349	297	0	349	0	147	0	0	0	2936	914
Arrive On Green	0.00	0.19	0.19	0.00	0.00	0.00	0.08	0.00	0.00	0.00	0.60	0.60
Sat Flow, veh/h	0	1863	1583	0	1863	0	1757	55		0	5055	1524
Grp Volume(v), veh/h	0	273	63	0	0	0	55	32.4		0	784	176
Grp Sat Flow(s),veh/h/ln	0	1863	1583	0	1863	0	1757	C		0	1631	1524
Q Serve(g_s), s	0.0	9.9	2.4	0.0	0.0	0.0	2.1			0.0	5.4	3.7
Cycle Q Clear(g_c), s	0.0	9.9	2.4	0.0	0.0	0.0	2.1			0.0	5.4	3.7
Prop In Lane	0.00		1.00	0.00		0.00	1.00			0.00		1.00
Lane Grp Cap(c), veh/h	0	349	297	0	349	0	147			0	2936	914
V/C Ratio(X)	0.00	0.78	0.21	0.00	0.00	0.00	0.37			0.00	0.27	0.19
Avail Cap(c_a), veh/h	0	681	579	0	681	0	272			0	2936	914
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00			1.00	1.00	1.00
Upstream Filter(I)	0.00	1.00	1.00	0.00	0.00	0.00	1.00			0.00	1.00	1.00
Uniform Delay (d), s/veh	0.0	27.5	24.5	0.0	0.0	0.0	30.8			0.0	6.8	6.4
Incr Delay (d2), s/veh	0.0	3.8	0.4	0.0	0.0	0.0	1.6			0.0	0.2	0.5
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0			0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	0.0	5.5	1.1	0.0	0.0	0.0	1.1			0.0	2.5	1.7
LnGrp Delay(d),s/veh	0.0	31.4	24.8	0.0	0.0	0.0	32.4			0.0	7.0	6.9
LnGrp LOS		C	C				C				A	A
Approach Vol, veh/h		336			0						960	
Approach Delay, s/veh		30.1			0.0						7.0	
Approach LOS		C									A	

Timer	1	2	3	4	5	6	7	8
Assigned Phs	1	2		4				8
Phs Duration (G+Y+Rc), s	12.0	48.7		19.3				19.3
Change Period (Y+Rc), s	6.0	6.0		6.0				6.0
Max Green Setting (Gmax), s	11.0	25.0		26.0				26.0
Max Q Clear Time (g_c+I1), s	4.1	7.4		11.9				0.0
Green Ext Time (p_c), s	0.0	5.3		1.4				0.0

Intersection Summary	
HCM 2010 Ctrl Delay	13.8
HCM 2010 LOS	B

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	0	0	0	0	8	102	0	438	40	27	0	0
Number	7	4	14	3	8	18	1	6	16	5	2	12
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	0	1863	0	0	1743	1743	0	1681	1900	1810	0	0
Adj Flow Rate, veh/h	0	0	0	0	8	104	0	447	41	28	0	0
Adj No. of Lanes	0	1	0	0	1	1	0	3	0	1	0	0
Peak Hour Factor	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98
Percent Heavy Veh, %	0	2	0	0	9	9	0	13	13	5	0	0
Cap, veh/h	0	176	0	0	164	894	0	1858	168	99	0	0
Arrive On Green	0.00	0.00	0.00	0.00	0.09	0.17	0.00	0.43	0.43	0.06	0.00	0.00
Sat Flow, veh/h	0	1863	0	0	1743	1482	0	4436	388	1723	28	
Grp Volume(v), veh/h	0	0	0	0	8	104	0	318	170	28	25.5	
Grp Sat Flow(s),veh/h/ln	0	1863	0	0	1743	1482	0	1530	1613	1723	C	
Q Serve(g_s), s	0.0	0.0	0.0	0.0	0.2	1.6	0.0	3.5	3.5	0.8		
Cycle Q Clear(g_c), s	0.0	0.0	0.0	0.0	0.2	1.6	0.0	3.5	3.5	0.8		
Prop In Lane	0.00		0.00	0.00		1.00	0.00		0.24	1.00		
Lane Grp Cap(c), veh/h	0	176	0	0	164	894	0	1327	699	99		
V/C Ratio(X)	0.00	0.00	0.00	0.00	0.05	0.12	0.00	0.24	0.24	0.28		
Avail Cap(c_a), veh/h	0	492	0	0	460	1145	0	1327	699	357		
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00		
Upstream Filter(I)	0.00	0.00	0.00	0.00	1.00	1.00	0.00	1.00	1.00	1.00		
Uniform Delay (d), s/veh	0.0	0.0	0.0	0.0	21.9	4.5	0.0	9.5	9.5	24.0		
Incr Delay (d2), s/veh	0.0	0.0	0.0	0.0	0.1	0.1	0.0	0.4	0.8	1.5		
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		
%ile BackOfQ(50%),veh/ln	0.0	0.0	0.0	0.0	0.1	1.4	0.0	1.5	1.7	0.4		
LnGrp Delay(d),s/veh	0.0	0.0	0.0	0.0	22.0	4.5	0.0	9.9	10.3	25.5		
LnGrp LOS					C	A		A	B	C		
Approach Vol, veh/h		0			112			488				
Approach Delay, s/veh		0.0			5.8			10.1				
Approach LOS					A			B				

Timer	1	2	3	4	5	6	7	8
Assigned Phs				4	5	6		8
Phs Duration (G+Y+Rc), s				15.0	9.0	29.0		15.0
Change Period (Y+Rc), s				6.0	6.0	6.0		6.0
Max Green Setting (Gmax), s				18.0	11.0	23.0		18.0
Max Q Clear Time (g_c+I1), s				0.0	2.8	5.5		3.6
Green Ext Time (p_c), s				0.0	0.0	2.6		0.3

Intersection Summary	
HCM 2010 Ctrl Delay	10.0
HCM 2010 LOS	A

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	0	0	0	0	4	148	0	1074	78	8	0	0
Number	7	4	14	3	8	18	1	6	16	5	2	12
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	0	1863	0	0	1863	1863	0	1827	1900	1776	0	0
Adj Flow Rate, veh/h	0	0	0	0	4	159	0	1155	84	9	0	0
Adj No. of Lanes	0	1	0	0	1	1	0	3	0	1	0	0
Peak Hour Factor	0.90	0.90	0.90	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93
Percent Heavy Veh, %	0	2	0	0	2	2	0	4	4	7	0	0
Cap, veh/h	0	238	0	0	238	1125	0	2765	201	35	0	0
Arrive On Green	0.00	0.00	0.00	0.00	0.13	0.13	0.00	0.58	0.58	0.02	0.00	0.00
Sat Flow, veh/h	0	1863	0	0	1863	1583	0	4910	345	1691	9	
Grp Volume(v), veh/h	0	0	0	0	4	159	0	809	430	9	36.1	
Grp Sat Flow(s),veh/h/ln	0	1863	0	0	1863	1583	0	1663	1766	1691	D	
Q Serve(g_s), s	0.0	0.0	0.0	0.0	0.1	2.2	0.0	9.0	9.0	0.4		
Cycle Q Clear(g_c), s	0.0	0.0	0.0	0.0	0.1	2.2	0.0	9.0	9.0	0.4		
Prop In Lane	0.00		0.00	0.00		1.00	0.00		0.20	1.00		
Lane Grp Cap(c), veh/h	0	238	0	0	238	1125	0	1937	1029	35		
V/C Ratio(X)	0.00	0.00	0.00	0.00	0.02	0.14	0.00	0.42	0.42	0.26		
Avail Cap(c_a), veh/h	0	278	0	0	278	1159	0	1937	1029	328		
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00		
Upstream Filter(I)	0.00	0.00	0.00	0.00	1.00	1.00	0.00	1.00	1.00	1.00		
Uniform Delay (d), s/veh	0.0	0.0	0.0	0.0	25.5	3.1	0.0	7.7	7.7	32.3		
Incr Delay (d2), s/veh	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.7	1.3	3.8		
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		
%ile BackOfQ(50%),veh/ln	0.0	0.0	0.0	0.0	0.1	2.8	0.0	4.2	4.7	0.2		
LnGrp Delay(d),s/veh	0.0	0.0	0.0	0.0	25.5	3.2	0.0	8.4	9.0	36.1		
LnGrp LOS					C	A		A	A	D		
Approach Vol, veh/h		0			163			1239				
Approach Delay, s/veh		0.0			3.7			8.6				
Approach LOS					A			A				

Timer	1	2	3	4	5	6	7	8
Assigned Phs				4	5	6		8
Phs Duration (G+Y+Rc), s				14.6	7.4	45.0		14.6
Change Period (Y+Rc), s				6.0	6.0	6.0		6.0
Max Green Setting (Gmax), s				10.0	13.0	39.0		10.0
Max Q Clear Time (g_c+I1), s				0.0	2.4	11.0		4.2
Green Ext Time (p_c), s				0.0	0.0	8.8		0.2

Intersection Summary	
HCM 2010 Ctrl Delay	8.2
HCM 2010 LOS	A

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	0	0	0	0	126	53	0	432	39	117	0	0
Number	7	4	14	3	8	18	1	6	16	5	2	12
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	0	1863	0	0	1759	1759	0	1667	1667	1810	0	0
Adj Flow Rate, veh/h	0	0	0	0	126	53	0	432	39	117	0	0
Adj No. of Lanes	0	1	0	0	1	1	0	3	1	1	0	0
Peak Hour Factor	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Percent Heavy Veh, %	0	2	0	0	8	8	0	14	14	5	0	0
Cap, veh/h	0	281	0	0	265	813	0	1788	557	232	0	0
Arrive On Green	0.00	0.00	0.00	0.00	0.15	0.15	0.00	0.39	0.39	0.13	0.00	0.00
Sat Flow, veh/h	0	1863	0	0	1759	1495	0	4700	1417	1723	117	
Grp Volume(v), veh/h	0	0	0	0	126	53	0	432	39	117	24.2	
Grp Sat Flow(s),veh/h/ln	0	1863	0	0	1759	1495	0	1517	1417	1723	C	
Q Serve(g_s), s	0.0	0.0	0.0	0.0	3.7	0.9	0.0	3.6	1.0	3.5		
Cycle Q Clear(g_c), s	0.0	0.0	0.0	0.0	3.7	0.9	0.0	3.6	1.0	3.5		
Prop In Lane	0.00		0.00	0.00		1.00	0.00		1.00	1.00		
Lane Grp Cap(c), veh/h	0	281	0	0	265	813	0	1788	557	232		
V/C Ratio(X)	0.00	0.00	0.00	0.00	0.47	0.07	0.00	0.24	0.07	0.50		
Avail Cap(c_a), veh/h	0	499	0	0	471	988	0	1788	557	462		
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00		
Upstream Filter(I)	0.00	0.00	0.00	0.00	1.00	1.00	0.00	1.00	1.00	1.00		
Uniform Delay (d), s/veh	0.0	0.0	0.0	0.0	21.7	6.0	0.0	11.4	10.6	22.5		
Incr Delay (d2), s/veh	0.0	0.0	0.0	0.0	1.3	0.0	0.0	0.3	0.2	1.7		
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		
%ile BackOfQ(50%),veh/ln	0.0	0.0	0.0	0.0	1.9	0.7	0.0	1.5	0.4	1.8		
LnGrp Delay(d),s/veh	0.0	0.0	0.0	0.0	23.1	6.1	0.0	11.7	10.9	24.2		
LnGrp LOS					C	A		B	B	C		
Approach Vol, veh/h		0			179			471				
Approach Delay, s/veh		0.0			18.0			11.6				
Approach LOS					B			B				

Timer	1	2	3	4	5	6	7	8
Assigned Phs				4	5	6		8
Phs Duration (G+Y+Rc), s				14.4	13.5	28.0		14.4
Change Period (Y+Rc), s				6.0	6.0	6.0		6.0
Max Green Setting (Gmax), s				15.0	15.0	22.0		15.0
Max Q Clear Time (g_c+I1), s				0.0	5.5	5.6		5.7
Green Ext Time (p_c), s				0.0	0.2	2.5		0.5

Intersection Summary	
HCM 2010 Ctrl Delay	15.0
HCM 2010 LOS	B

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	0	0	0	0	83	106	0	1054	65	88	0	0
Number	7	4	14	3	8	18	1	6	16	5	2	12
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	0	1863	0	0	1863	1863	0	1827	1827	1776	0	0
Adj Flow Rate, veh/h	0	0	0	0	87	112	0	1109	68	93	0	0
Adj No. of Lanes	0	1	0	0	1	1	0	3	1	1	0	0
Peak Hour Factor	0.90	0.90	0.90	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Percent Heavy Veh, %	0	2	0	0	2	2	0	4	4	7	0	0
Cap, veh/h	0	237	0	0	237	1001	0	2519	784	183	0	0
Arrive On Green	0.00	0.00	0.00	0.00	0.13	0.13	0.00	0.51	0.51	0.11	0.00	0.00
Sat Flow, veh/h	0	1863	0	0	1863	1583	0	5152	1553	1691	93	
Grp Volume(v), veh/h	0	0	0	0	87	112	0	1109	68	93	31.3	
Grp Sat Flow(s),veh/h/ln	0	1863	0	0	1863	1583	0	1663	1553	1691	C	
Q Serve(g_s), s	0.0	0.0	0.0	0.0	3.0	1.9	0.0	9.8	1.6	3.6		
Cycle Q Clear(g_c), s	0.0	0.0	0.0	0.0	3.0	1.9	0.0	9.8	1.6	3.6		
Prop In Lane	0.00		0.00	0.00		1.00	0.00		1.00	1.00		
Lane Grp Cap(c), veh/h	0	237	0	0	237	1001	0	2519	784	183		
V/C Ratio(X)	0.00	0.00	0.00	0.00	0.37	0.11	0.00	0.44	0.09	0.51		
Avail Cap(c_a), veh/h	0	349	0	0	349	1097	0	2519	784	342		
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00		
Upstream Filter(I)	0.00	0.00	0.00	0.00	1.00	1.00	0.00	1.00	1.00	1.00		
Uniform Delay (d), s/veh	0.0	0.0	0.0	0.0	27.7	5.0	0.0	10.9	8.9	29.2		
Incr Delay (d2), s/veh	0.0	0.0	0.0	0.0	1.0	0.0	0.0	0.6	0.2	2.2		
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		
%ile BackOfQ(50%),veh/ln	0.0	0.0	0.0	0.0	1.6	2.0	0.0	4.5	0.7	1.8		
LnGrp Delay(d),s/veh	0.0	0.0	0.0	0.0	28.6	5.1	0.0	11.5	9.1	31.3		
LnGrp LOS					C	A		B	A	C		
Approach Vol, veh/h		0			199			1177				
Approach Delay, s/veh		0.0			15.4			11.3				
Approach LOS					B			B				

Timer	1	2	3	4	5	6	7	8
Assigned Phs				4	5	6		8
Phs Duration (G+Y+Rc), s				14.8	13.5	41.0		14.8
Change Period (Y+Rc), s				6.0	6.0	6.0		6.0
Max Green Setting (Gmax), s				13.0	14.0	35.0		13.0
Max Q Clear Time (g_c+I1), s				0.0	5.6	11.8		5.0
Green Ext Time (p_c), s				0.0	0.1	8.0		0.5

Intersection Summary	
HCM 2010 Ctrl Delay	13.2
HCM 2010 LOS	B

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Volume (veh/h)	64	15	35	457	727	125
Number	3	18	1	6	2	12
Initial Q (Qb), veh	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00	1.00	1.00			1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1570	1570	1776	1776	1792	1792
Adj Flow Rate, veh/h	70	16	38	497	790	136
Adj No. of Lanes	2	1	1	3	3	1
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92
Percent Heavy Veh, %	21	21	7	7	6	6
Cap, veh/h	315	145	530	3762	3798	1182
Arrive On Green	0.11	0.11	0.26	0.26	0.78	0.78
Sat Flow, veh/h	2901	1335	573	5007	5055	1524
Grp Volume(v), veh/h	70	16	38	497	790	136
Grp Sat Flow(s),veh/h/ln	1451	1335	573	1616	1631	1524
Q Serve(g_s), s	1.4	0.7	3.4	5.2	2.8	1.4
Cycle Q Clear(g_c), s	1.4	0.7	6.2	5.2	2.8	1.4
Prop In Lane	1.00	1.00	1.00			1.00
Lane Grp Cap(c), veh/h	315	145	530	3762	3798	1182
V/C Ratio(X)	0.22	0.11	0.07	0.13	0.21	0.12
Avail Cap(c_a), veh/h	708	326	530	3762	3798	1182
HCM Platoon Ratio	1.00	1.00	0.33	0.33	1.00	1.00
Upstream Filter(I)	1.00	1.00	0.97	0.97	1.00	1.00
Uniform Delay (d), s/veh	26.7	26.4	8.9	7.4	2.0	1.8
Incr Delay (d2), s/veh	0.4	0.3	0.3	0.1	0.1	0.2
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	0.6	0.3	0.6	2.3	1.3	0.7
LnGrp Delay(d),s/veh	27.0	26.7	9.1	7.5	2.1	2.0
LnGrp LOS	C	C	A	A	A	A
Approach Vol, veh/h	86			535	926	
Approach Delay, s/veh	27.0			7.6	2.1	
Approach LOS	C			A	A	

Timer	1	2	3	4	5	6	7	8
Assigned Phs		2				6		8
Phs Duration (G+Y+Rc), s		56.9				56.9		13.1
Change Period (Y+Rc), s		6.0				6.0		6.0
Max Green Setting (Gmax), s		42.0				42.0		16.0
Max Q Clear Time (g_c+I1), s		4.8				8.2		3.4
Green Ext Time (p_c), s		11.6				11.3		0.2

Intersection Summary	
HCM 2010 Ctrl Delay	5.4
HCM 2010 LOS	A

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Volume (veh/h)	101	41	27	936	690	64
Number	3	18	1	6	2	12
Initial Q (Qb), veh	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00	1.00	1.00			1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1759	1759	1845	1845	1759	1759
Adj Flow Rate, veh/h	104	42	28	965	711	66
Adj No. of Lanes	2	1	1	3	3	1
Peak Hour Factor	0.97	0.97	0.97	0.97	0.97	0.97
Percent Heavy Veh, %	8	8	3	3	8	8
Cap, veh/h	372	171	616	4002	3817	1188
Arrive On Green	0.11	0.11	0.79	0.79	0.79	0.79
Sat Flow, veh/h	3250	1495	685	5202	4961	1495
Grp Volume(v), veh/h	104	42	28	965	711	66
Grp Sat Flow(s),veh/h/ln	1625	1495	685	1679	1601	1495
Q Serve(g_s), s	2.2	1.9	0.8	3.6	2.7	0.7
Cycle Q Clear(g_c), s	2.2	1.9	3.4	3.6	2.7	0.7
Prop In Lane	1.00	1.00	1.00			1.00
Lane Grp Cap(c), veh/h	372	171	616	4002	3817	1188
V/C Ratio(X)	0.28	0.25	0.05	0.24	0.19	0.06
Avail Cap(c_a), veh/h	826	380	616	4002	3817	1188
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	0.68	0.68	1.00	1.00
Uniform Delay (d), s/veh	30.3	30.2	2.3	1.9	1.8	1.6
Incr Delay (d2), s/veh	0.4	0.7	0.1	0.1	0.1	0.1
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	1.0	0.8	0.2	1.6	1.2	0.3
LnGrp Delay(d),s/veh	30.7	30.9	2.4	2.0	2.0	1.7
LnGrp LOS	C	C	A	A	A	A
Approach Vol, veh/h	146			993	777	
Approach Delay, s/veh	30.7			2.1	1.9	
Approach LOS	C			A	A	

Timer	1	2	3	4	5	6	7	8
Assigned Phs		2				6		8
Phs Duration (G+Y+Rc), s		65.4				65.4		14.6
Change Period (Y+Rc), s		6.0				6.0		6.0
Max Green Setting (Gmax), s		49.0				49.0		19.0
Max Q Clear Time (g_c+I1), s		4.7				5.6		4.2
Green Ext Time (p_c), s		16.4				16.3		0.4

Intersection Summary	
HCM 2010 Ctrl Delay	4.2
HCM 2010 LOS	A

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	47	55	4	101	77	95	14	297	154	125	440	114
Number	3	8	18	7	4	14	1	6	16	5	2	12
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1827	1827	1900	1827	1827	1827	1900	1810	1900	1792	1792	1792
Adj Flow Rate, veh/h	53	62	4	113	87	107	16	334	173	140	494	128
Adj No. of Lanes	1	1	0	1	1	1	0	3	0	1	2	1
Peak Hour Factor	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89
Percent Heavy Veh, %	4	4	4	4	4	4	5	5	5	6	6	6
Cap, veh/h	425	621	40	371	373	317	73	877	387	453	1636	845
Arrive On Green	0.07	0.37	0.37	0.20	0.20	0.20	0.28	0.28	0.28	0.23	0.96	0.96
Sat Flow, veh/h	1740	1698	110	1304	1827	1553	57	3174	1400	1707	3406	1524
Grp Volume(v), veh/h	53	0	66	113	87	107	190	160	173	140	494	128
Grp Sat Flow(s),veh/h/ln	1740	0	1808	1304	1827	1553	1733	1498	1400	1707	1703	1524
Q Serve(g_s), s	1.5	0.0	1.6	5.2	2.7	4.0	0.0	5.9	7.0	3.4	0.5	0.2
Cycle Q Clear(g_c), s	1.5	0.0	1.6	5.2	2.7	4.0	5.8	5.9	7.0	3.4	0.5	0.2
Prop In Lane	1.00		0.06	1.00		1.00	0.08		1.00	1.00		1.00
Lane Grp Cap(c), veh/h	425	0	661	371	373	317	536	414	387	453	1636	845
V/C Ratio(X)	0.12	0.00	0.10	0.30	0.23	0.34	0.35	0.39	0.45	0.31	0.30	0.15
Avail Cap(c_a), veh/h	499	0	738	372	373	317	536	414	387	453	1636	845
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	2.00	2.00	2.00
Upstream Filter(I)	1.00	0.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.99	0.99	0.99
Uniform Delay (d), s/veh	17.1	0.0	14.3	23.8	22.8	23.3	20.1	20.1	20.5	11.4	0.7	0.5
Incr Delay (d2), s/veh	0.1	0.0	0.1	0.5	0.3	0.6	1.8	2.7	3.7	0.4	0.5	0.4
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	0.7	0.0	0.8	1.9	1.4	1.8	3.2	2.8	3.1	1.5	0.3	0.2
LnGrp Delay(d),s/veh	17.3	0.0	14.4	24.2	23.1	23.9	21.9	22.8	24.2	11.8	1.2	0.9
LnGrp LOS	B		B	C	C	C	C	C	C	B	A	A
Approach Vol, veh/h		119			307			523			762	
Approach Delay, s/veh		15.7			23.8			22.9			3.1	
Approach LOS		B			C			C			A	

Timer	1	2	3	4	5	6	7	8
Assigned Phs		2	3	4	5	6		8
Phs Duration (G+Y+Rc), s		38.9	11.1	20.0	14.0	24.9		31.1
Change Period (Y+Rc), s		6.0	6.0	6.0	6.0	6.0		6.0
Max Green Setting (Gmax), s		30.0	8.0	14.0	8.0	16.0		28.0
Max Q Clear Time (g_c+I1), s		2.5	3.5	7.2	5.4	9.0		3.6
Green Ext Time (p_c), s		7.7	0.0	0.9	0.1	3.7		1.5

Intersection Summary	
HCM 2010 Ctrl Delay	13.7
HCM 2010 LOS	B

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	104	104	5	104	47	137	4	748	202	127	456	115
Number	3	8	18	7	4	14	1	6	16	5	2	12
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1792	1792	1900	1863	1863	1863	1900	1863	1900	1845	1845	1845
Adj Flow Rate, veh/h	113	113	5	113	51	149	4	813	220	138	496	125
Adj No. of Lanes	1	1	0	1	1	1	0	3	0	1	2	1
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Percent Heavy Veh, %	6	6	6	2	2	2	2	2	2	3	3	3
Cap, veh/h	470	647	29	345	374	318	47	1106	296	339	1661	906
Arrive On Green	0.10	0.38	0.38	0.20	0.20	0.20	0.29	0.29	0.29	0.23	0.95	0.95
Sat Flow, veh/h	1707	1704	75	1269	1863	1583	4	3871	1036	1757	3505	1568
Grp Volume(v), veh/h	113	0	118	113	51	149	391	325	321	138	496	125
Grp Sat Flow(s),veh/h/ln	1707	0	1779	1269	1863	1583	1857	1543	1512	1757	1752	1568
Q Serve(g_s), s	3.8	0.0	3.5	6.2	1.8	6.6	0.0	15.2	15.3	3.7	0.8	0.3
Cycle Q Clear(g_c), s	3.8	0.0	3.5	6.2	1.8	6.6	15.1	15.2	15.3	3.7	0.8	0.3
Prop In Lane	1.00		0.04	1.00		1.00	0.01		0.69	1.00		1.00
Lane Grp Cap(c), veh/h	470	0	676	345	374	318	576	441	432	339	1661	906
V/C Ratio(X)	0.24	0.00	0.17	0.33	0.14	0.47	0.68	0.74	0.74	0.41	0.30	0.14
Avail Cap(c_a), veh/h	486	0	693	345	374	318	576	441	432	339	1661	906
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	2.00	2.00	2.00
Upstream Filter(I)	1.00	0.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.99	0.99	0.99
Uniform Delay (d), s/veh	19.3	0.0	16.4	27.9	26.1	28.1	25.7	25.7	25.8	14.6	1.1	0.7
Incr Delay (d2), s/veh	0.3	0.0	0.1	0.5	0.2	1.1	6.3	10.5	11.0	0.8	0.5	0.3
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	1.8	0.0	1.7	2.2	0.9	3.0	8.7	7.7	7.7	1.9	0.4	0.2
LnGrp Delay(d),s/veh	19.5	0.0	16.5	28.5	26.3	29.1	32.1	36.3	36.8	15.4	1.6	1.0
LnGrp LOS	B		B	C	C	C	C	D	D	B	A	A
Approach Vol, veh/h		231			313			1037			759	
Approach Delay, s/veh		18.0			28.4			34.9			4.0	
Approach LOS		B			C			C			A	

Timer	1	2	3	4	5	6	7	8
Assigned Phs		2	3	4	5	6		8
Phs Duration (G+Y+Rc), s		43.7	14.3	22.0	15.0	28.7		36.3
Change Period (Y+Rc), s		6.0	6.0	6.0	6.0	6.0		6.0
Max Green Setting (Gmax), s		37.0	9.0	16.0	9.0	22.0		31.0
Max Q Clear Time (g_c+I1), s		2.8	5.8	8.6	5.7	17.3		5.5
Green Ext Time (p_c), s		13.2	0.1	1.1	0.1	3.5		1.8

Intersection Summary	
HCM 2010 Ctrl Delay	22.3
HCM 2010 LOS	C

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	4	7	5	43	9	12	4	451	15	14	516	4
Number	3	8	18	7	4	14	1	6	16	5	2	12
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1900	1759	1900	1900	1827	1900	1810	1810	1900	1792	1792	1900
Adj Flow Rate, veh/h	4	7	5	44	9	12	4	465	15	14	532	4
Adj No. of Lanes	0	1	0	0	1	0	1	2	0	1	2	0
Peak Hour Factor	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97
Percent Heavy Veh, %	8	8	8	4	4	4	5	5	5	6	6	6
Cap, veh/h	170	220	122	378	81	67	471	1468	47	494	1496	11
Arrive On Green	0.24	0.24	0.24	0.24	0.24	0.24	0.43	0.43	0.43	0.43	0.43	0.43
Sat Flow, veh/h	199	902	501	880	331	274	840	3400	110	877	3465	26
Grp Volume(v), veh/h	16	0	0	65	0	0	4	235	245	14	261	275
Grp Sat Flow(s),veh/h/ln	1602	0	0	1485	0	0	840	1719	1790	877	1703	1788
Q Serve(g_s), s	0.0	0.0	0.0	0.1	0.0	0.0	0.1	3.3	3.3	0.4	3.8	3.8
Cycle Q Clear(g_c), s	0.3	0.0	0.0	1.1	0.0	0.0	3.9	3.3	3.3	3.7	3.8	3.8
Prop In Lane	0.25		0.31	0.68		0.18	1.00		0.06	1.00		0.01
Lane Grp Cap(c), veh/h	513	0	0	526	0	0	471	742	773	494	735	772
V/C Ratio(X)	0.03	0.00	0.00	0.12	0.00	0.00	0.01	0.32	0.32	0.03	0.36	0.36
Avail Cap(c_a), veh/h	927	0	0	916	0	0	1106	2042	2126	1157	2022	2123
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	0.00	0.00	1.00	0.00	0.00	1.00	1.00	1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	10.7	0.0	0.0	11.0	0.0	0.0	8.4	6.9	6.9	8.2	7.1	7.1
Incr Delay (d2), s/veh	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.2	0.2	0.0	0.3	0.3
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	0.1	0.0	0.0	0.5	0.0	0.0	0.0	1.6	1.7	0.1	1.8	1.9
LnGrp Delay(d),s/veh	10.7	0.0	0.0	11.1	0.0	0.0	8.4	7.2	7.2	8.2	7.4	7.3
LnGrp LOS	B			B			A	A	A	A	A	A
Approach Vol, veh/h		16			65			484			550	
Approach Delay, s/veh		10.7			11.1			7.2			7.4	
Approach LOS		B			B			A			A	

Timer	1	2	3	4	5	6	7	8
Assigned Phs		2		4		6		8
Phs Duration (G+Y+Rc), s		22.0		15.0		22.0		15.0
Change Period (Y+Rc), s		6.0		6.0		6.0		6.0
Max Green Setting (Gmax), s		44.0		19.0		44.0		19.0
Max Q Clear Time (g_c+I1), s		5.8		3.1		5.9		2.3
Green Ext Time (p_c), s		7.1		0.3		7.1		0.3

Intersection Summary	
HCM 2010 Ctrl Delay	7.5
HCM 2010 LOS	A

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	4	6	4	27	11	21	5	927	41	17	520	8
Number	3	8	18	7	4	14	1	6	16	5	2	12
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1900	1863	1900	1900	1863	1900	1863	1863	1900	1863	1863	1900
Adj Flow Rate, veh/h	4	6	4	28	12	22	5	976	43	18	547	8
Adj No. of Lanes	0	1	0	0	1	0	1	2	0	1	2	0
Peak Hour Factor	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Percent Heavy Veh, %	2	2	2	2	2	2	2	2	2	2	2	2
Cap, veh/h	158	199	103	227	105	121	530	1819	80	342	1881	28
Arrive On Green	0.22	0.22	0.22	0.22	0.22	0.22	0.53	0.53	0.53	0.53	0.53	0.53
Sat Flow, veh/h	274	926	480	534	490	563	850	3453	152	551	3571	52
Grp Volume(v), veh/h	14	0	0	62	0	0	5	500	519	18	271	284
Grp Sat Flow(s),veh/h/ln	1679	0	0	1586	0	0	850	1770	1836	551	1770	1854
Q Serve(g_s), s	0.0	0.0	0.0	0.0	0.0	0.0	0.2	8.7	8.7	1.0	4.0	4.0
Cycle Q Clear(g_c), s	0.3	0.0	0.0	1.3	0.0	0.0	4.1	8.7	8.7	9.7	4.0	4.0
Prop In Lane	0.29		0.29	0.45		0.35	1.00		0.08	1.00		0.03
Lane Grp Cap(c), veh/h	461	0	0	454	0	0	530	932	967	342	932	976
V/C Ratio(X)	0.03	0.00	0.00	0.14	0.00	0.00	0.01	0.54	0.54	0.05	0.29	0.29
Avail Cap(c_a), veh/h	773	0	0	751	0	0	886	1674	1737	573	1674	1754
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	0.00	0.00	1.00	0.00	0.00	1.00	1.00	1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	14.4	0.0	0.0	14.8	0.0	0.0	7.3	7.3	7.3	10.5	6.1	6.1
Incr Delay (d2), s/veh	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.5	0.5	0.1	0.2	0.2
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	0.1	0.0	0.0	0.7	0.0	0.0	0.0	4.3	4.4	0.2	1.9	2.0
LnGrp Delay(d),s/veh	14.5	0.0	0.0	15.0	0.0	0.0	7.3	7.7	7.7	10.5	6.3	6.3
LnGrp LOS	B			B			A	A	A	B	A	A
Approach Vol, veh/h		14			62			1024			573	
Approach Delay, s/veh		14.5			15.0			7.7			6.4	
Approach LOS		B			B			A			A	

Timer	1	2	3	4	5	6	7	8
Assigned Phs		2		4		6		8
Phs Duration (G+Y+Rc), s		30.5		16.0		30.5		16.0
Change Period (Y+Rc), s		6.0		6.0		6.0		6.0
Max Green Setting (Gmax), s		44.0		19.0		44.0		19.0
Max Q Clear Time (g_c+I1), s		11.7		3.3		10.7		2.3
Green Ext Time (p_c), s		12.8		0.3		12.9		0.3

Intersection Summary	
HCM 2010 Ctrl Delay	7.6
HCM 2010 LOS	A

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	24	33	7	121	70	107	6	432	213	109	528	28
Number	3	8	18	7	4	14	1	6	16	5	2	12
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1900	1863	1900	1900	1810	1810	1810	1810	1810	1810	1810	1810
Adj Flow Rate, veh/h	25	35	7	127	74	113	6	455	224	115	556	29
Adj No. of Lanes	0	2	0	0	1	1	1	2	1	1	2	1
Peak Hour Factor	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95	0.95
Percent Heavy Veh, %	2	2	2	5	5	5	5	5	5	5	5	5
Cap, veh/h	180	304	63	258	122	328	501	1734	776	655	2384	1067
Arrive On Green	0.21	0.21	0.21	0.21	0.21	0.21	1.00	1.00	1.00	0.11	0.69	0.69
Sat Flow, veh/h	415	1424	294	843	573	1538	803	3438	1538	1723	3438	1538
Grp Volume(v), veh/h	28	0	39	201	0	113	6	455	224	115	556	29
Grp Sat Flow(s),veh/h/ln	490	0	1643	1416	0	1538	803	1719	1538	1723	1719	1538
Q Serve(g_s), s	1.2	0.0	1.4	8.6	0.0	4.7	0.0	0.0	0.0	1.9	4.4	0.4
Cycle Q Clear(g_c), s	11.2	0.0	1.4	10.0	0.0	4.7	0.0	0.0	0.0	1.9	4.4	0.4
Prop In Lane	0.90		0.18	0.63		1.00	1.00		1.00	1.00		1.00
Lane Grp Cap(c), veh/h	196	0	350	380	0	328	501	1734	776	655	2384	1067
V/C Ratio(X)	0.14	0.00	0.11	0.53	0.00	0.34	0.01	0.26	0.29	0.18	0.23	0.03
Avail Cap(c_a), veh/h	361	0	570	576	0	533	501	1734	776	720	2384	1067
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	2.00	2.00	2.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	0.00	1.00	1.00	0.00	1.00	0.96	0.96	0.96	0.99	0.99	0.99
Uniform Delay (d), s/veh	30.2	0.0	23.8	27.3	0.0	25.1	0.0	0.0	0.0	5.2	4.2	3.6
Incr Delay (d2), s/veh	0.3	0.0	0.1	1.1	0.0	0.6	0.0	0.4	0.9	0.1	0.2	0.0
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	0.6	0.0	0.7	3.9	0.0	2.0	0.0	0.1	0.2	0.9	2.2	0.2
LnGrp Delay(d),s/veh	30.5	0.0	23.9	28.5	0.0	25.7	0.0	0.4	0.9	5.4	4.4	3.6
LnGrp LOS	C		C	C		C	A	A	A	A	A	A
Approach Vol, veh/h		67			314			685			700	
Approach Delay, s/veh		26.6			27.5			0.5			4.6	
Approach LOS		C			C			A			A	

Timer	1	2	3	4	5	6	7	8
Assigned Phs		2		4	5	6		8
Phs Duration (G+Y+Rc), s		58.0		22.0	14.2	43.8		22.0
Change Period (Y+Rc), s		6.0		6.0	6.0	6.0		6.0
Max Green Setting (Gmax), s		42.0		26.0	11.0	25.0		26.0
Max Q Clear Time (g_c+I1), s		6.4		12.0	3.9	2.0		13.2
Green Ext Time (p_c), s		9.3		1.6	0.1	8.1		1.5

Intersection Summary	
HCM 2010 Ctrl Delay	7.9
HCM 2010 LOS	A

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	23	44	19	179	88	253	23	744	171	88	495	38
Number	3	8	18	7	4	14	1	6	16	5	2	12
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1900	1810	1900	1900	1863	1863	1863	1863	1863	1863	1863	1863
Adj Flow Rate, veh/h	25	48	21	195	96	275	25	809	186	96	538	41
Adj No. of Lanes	0	2	0	0	1	1	1	2	1	1	2	1
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Percent Heavy Veh, %	5	5	5	2	2	2	2	2	2	2	2	2
Cap, veh/h	138	319	150	325	122	445	441	1484	664	471	2118	947
Arrive On Green	0.28	0.28	0.28	0.28	0.28	0.28	0.84	0.84	0.84	0.10	0.60	0.60
Sat Flow, veh/h	199	1134	534	880	433	1583	831	3539	1583	1774	3539	1583
Grp Volume(v), veh/h	33	0	61	291	0	275	25	809	186	96	538	41
Grp Sat Flow(s),veh/h/ln	314	0	1552	1314	0	1583	831	1770	1583	1774	1770	1583
Q Serve(g_s), s	1.2	0.0	2.3	14.3	0.0	11.7	0.4	5.3	1.9	2.0	5.6	0.8
Cycle Q Clear(g_c), s	17.7	0.0	2.3	16.6	0.0	11.7	0.4	5.3	1.9	2.0	5.6	0.8
Prop In Lane	0.76		0.34	0.67		1.00	1.00		1.00	1.00		1.00
Lane Grp Cap(c), veh/h	170	0	436	447	0	445	441	1484	664	471	2118	947
V/C Ratio(X)	0.19	0.00	0.14	0.65	0.00	0.62	0.06	0.55	0.28	0.20	0.25	0.04
Avail Cap(c_a), veh/h	245	0	542	547	0	553	441	1484	664	497	2118	947
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	2.00	2.00	2.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	0.00	1.00	0.95	0.00	0.95	0.93	0.93	0.93	0.98	0.98	0.98
Uniform Delay (d), s/veh	26.6	0.0	20.8	27.0	0.0	24.2	3.7	4.1	3.8	8.8	7.4	6.4
Incr Delay (d2), s/veh	0.5	0.0	0.1	1.9	0.0	1.3	0.2	1.3	1.0	0.2	0.3	0.1
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	0.7	0.0	1.0	6.0	0.0	5.3	0.1	2.6	0.9	1.0	2.8	0.4
LnGrp Delay(d),s/veh	27.2	0.0	21.0	28.9	0.0	25.5	3.9	5.4	4.8	9.0	7.6	6.5
LnGrp LOS	C		C	C		C	A	A	A	A	A	A
Approach Vol, veh/h		94			566			1020			675	
Approach Delay, s/veh		23.1			27.3			5.2			7.8	
Approach LOS		C			C			A			A	

Timer	1	2	3	4	5	6	7	8
Assigned Phs		2		4	5	6		8
Phs Duration (G+Y+Rc), s		52.3		27.7	13.9	38.4		27.7
Change Period (Y+Rc), s		6.0		6.0	6.0	6.0		6.0
Max Green Setting (Gmax), s		41.0		27.0	9.0	26.0		27.0
Max Q Clear Time (g_c+I1), s		7.6		18.6	4.0	7.3		19.7
Green Ext Time (p_c), s		12.9		2.2	0.1	9.8		2.0

Intersection Summary	
HCM 2010 Ctrl Delay	12.0
HCM 2010 LOS	B

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Volume (veh/h)	181	83	59	469	562	78
Number	3	18	1	6	2	12
Initial Q (Qb), veh	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00	1.00	1.00			1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1792	1792	1810	1810	1810	1810
Adj Flow Rate, veh/h	187	86	61	484	579	80
Adj No. of Lanes	1	1	1	2	2	1
Peak Hour Factor	0.97	0.97	0.97	0.97	0.97	0.97
Percent Heavy Veh, %	6	6	5	5	5	5
Cap, veh/h	246	219	723	2843	2843	1272
Arrive On Green	0.14	0.14	1.00	1.00	1.00	1.00
Sat Flow, veh/h	1707	1524	750	3529	3529	1538
Grp Volume(v), veh/h	187	86	61	484	579	80
Grp Sat Flow(s),veh/h/ln	1707	1524	750	1719	1719	1538
Q Serve(g_s), s	7.4	3.6	0.0	0.0	0.0	0.0
Cycle Q Clear(g_c), s	7.4	3.6	0.0	0.0	0.0	0.0
Prop In Lane	1.00	1.00	1.00			1.00
Lane Grp Cap(c), veh/h	246	219	723	2843	2843	1272
V/C Ratio(X)	0.76	0.39	0.08	0.17	0.20	0.06
Avail Cap(c_a), veh/h	731	653	723	2843	2843	1272
HCM Platoon Ratio	1.00	1.00	2.00	2.00	2.00	2.00
Upstream Filter(I)	0.97	0.97	0.92	0.92	0.97	0.97
Uniform Delay (d), s/veh	28.8	27.2	0.0	0.0	0.0	0.0
Incr Delay (d2), s/veh	4.7	1.1	0.2	0.1	0.2	0.1
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	3.8	1.6	0.0	0.0	0.1	0.0
LnGrp Delay(d),s/veh	33.5	28.3	0.2	0.1	0.2	0.1
LnGrp LOS	C	C	A	A	A	A
Approach Vol, veh/h	273			545	659	
Approach Delay, s/veh	31.9			0.1	0.1	
Approach LOS	C			A	A	

Timer	1	2	3	4	5	6	7	8
Assigned Phs		2				6		8
Phs Duration (G+Y+Rc), s		63.9				63.9		16.1
Change Period (Y+Rc), s		6.0				6.0		6.0
Max Green Setting (Gmax), s		38.0				38.0		30.0
Max Q Clear Time (g_c+I1), s		2.0				2.0		9.4
Green Ext Time (p_c), s		9.6				9.6		0.8

Intersection Summary	
HCM 2010 Ctrl Delay	6.0
HCM 2010 LOS	A

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Volume (veh/h)	163	76	149	773	558	146
Number	3	18	1	6	2	12
Initial Q (Qb), veh	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00	1.00	1.00			1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1845	1845	1863	1863	1863	1863
Adj Flow Rate, veh/h	172	80	157	814	587	154
Adj No. of Lanes	1	1	1	2	2	1
Peak Hour Factor	0.95	0.95	0.95	0.95	0.95	0.95
Percent Heavy Veh, %	3	3	2	2	2	2
Cap, veh/h	226	202	665	2807	2807	1256
Arrive On Green	0.13	0.13	1.00	1.00	1.00	1.00
Sat Flow, veh/h	1757	1568	715	3632	3632	1583
Grp Volume(v), veh/h	172	80	157	814	587	154
Grp Sat Flow(s),veh/h/ln	1757	1568	715	1770	1770	1583
Q Serve(g_s), s	7.0	3.5	0.0	0.0	0.0	0.0
Cycle Q Clear(g_c), s	7.0	3.5	0.0	0.0	0.0	0.0
Prop In Lane	1.00	1.00	1.00			1.00
Lane Grp Cap(c), veh/h	226	202	665	2807	2807	1256
V/C Ratio(X)	0.76	0.40	0.24	0.29	0.21	0.12
Avail Cap(c_a), veh/h	524	468	665	2807	2807	1256
HCM Platoon Ratio	1.00	1.00	2.00	2.00	2.00	2.00
Upstream Filter(I)	0.97	0.97	0.84	0.84	0.97	0.97
Uniform Delay (d), s/veh	31.0	29.5	0.0	0.0	0.0	0.0
Incr Delay (d2), s/veh	5.0	1.2	0.7	0.2	0.2	0.2
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	3.7	1.6	0.1	0.1	0.1	0.1
LnGrp Delay(d),s/veh	36.1	30.7	0.7	0.2	0.2	0.2
LnGrp LOS	D	C	A	A	A	A
Approach Vol, veh/h	252			971	741	
Approach Delay, s/veh	34.4			0.3	0.2	
Approach LOS	C			A	A	

Timer	1	2	3	4	5	6	7	8
Assigned Phs		2				6		8
Phs Duration (G+Y+Rc), s		64.5				64.5		15.5
Change Period (Y+Rc), s		6.0				6.0		6.0
Max Green Setting (Gmax), s		46.0				46.0		22.0
Max Q Clear Time (g_c+I1), s		2.0				2.0		9.0
Green Ext Time (p_c), s		16.5				16.5		0.6

Intersection Summary	
HCM 2010 Ctrl Delay	4.6
HCM 2010 LOS	A

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	276	476	208	14	188	16	84	212	10	46	356	236
Number	3	8	18	7	4	14	1	6	16	5	2	12
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1845	1845	1900	1759	1759	1900	1759	1759	1900	1810	1810	1810
Adj Flow Rate, veh/h	300	517	226	15	204	17	91	230	11	50	387	257
Adj No. of Lanes	1	2	0	1	2	0	1	2	0	1	2	1
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Percent Heavy Veh, %	3	3	3	8	8	8	8	8	8	5	5	5
Cap, veh/h	530	1029	448	227	632	52	389	1386	66	369	868	626
Arrive On Green	0.15	0.43	0.43	0.20	0.20	0.20	0.03	0.14	0.14	0.51	0.51	0.51
Sat Flow, veh/h	1757	2379	1036	674	3127	258	1675	3249	155	1102	3438	1538
Grp Volume(v), veh/h	300	380	363	15	108	113	91	118	123	50	387	257
Grp Sat Flow(s),veh/h/ln	1757	1752	1662	674	1671	1714	1675	1671	1732	1102	1719	1538
Q Serve(g_s), s	10.1	12.4	12.5	1.4	4.4	4.4	2.9	4.9	5.0	2.0	5.7	7.8
Cycle Q Clear(g_c), s	10.1	12.4	12.5	1.4	4.4	4.4	2.9	4.9	5.0	2.0	5.7	7.8
Prop In Lane	1.00		0.62	1.00		0.15	1.00		0.09	1.00		1.00
Lane Grp Cap(c), veh/h	530	758	719	227	338	347	389	713	739	369	868	626
V/C Ratio(X)	0.57	0.50	0.50	0.07	0.32	0.33	0.23	0.17	0.17	0.14	0.45	0.41
Avail Cap(c_a), veh/h	569	797	756	227	338	347	415	713	739	369	868	626
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	0.33	0.33	0.33	2.00	2.00	2.00
Upstream Filter(I)	0.74	0.74	0.74	0.99	0.99	0.99	1.00	1.00	1.00	0.98	0.98	0.98
Uniform Delay (d), s/veh	18.6	16.3	16.3	25.8	26.9	27.0	18.0	21.6	21.6	15.1	16.0	10.7
Incr Delay (d2), s/veh	0.8	0.4	0.4	0.1	0.5	0.5	0.3	0.5	0.5	0.7	1.6	1.9
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	4.9	6.1	5.8	0.3	2.1	2.1	1.4	2.4	2.5	0.7	2.8	3.6
LnGrp Delay(d),s/veh	19.4	16.6	16.7	25.9	27.5	27.5	18.3	22.1	22.1	15.9	17.7	12.7
LnGrp LOS	B	B	B	C	C	C	B	C	C	B	B	B
Approach Vol, veh/h		1043			236			332			694	
Approach Delay, s/veh		17.5			27.4			21.0			15.7	
Approach LOS		B			C			C			B	

Timer	1	2	3	4	5	6	7	8
Assigned Phs	1	2	3	4		6		8
Phs Duration (G+Y+Rc), s	13.8	26.0	18.2	22.0		39.8		40.2
Change Period (Y+Rc), s	6.0	6.0	6.0	6.0		6.0		6.0
Max Green Setting (Gmax), s	9.0	17.0	14.0	16.0		32.0		36.0
Max Q Clear Time (g_c+I1), s	4.9	9.8	12.1	6.4		7.0		14.5
Green Ext Time (p_c), s	0.1	2.9	0.2	4.1		5.2		6.2

Intersection Summary	
HCM 2010 Ctrl Delay	18.5
HCM 2010 LOS	B

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	300	253	102	17	423	53	245	504	35	45	346	284
Number	3	8	18	7	4	14	1	6	16	5	2	12
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1845	1845	1900	1845	1845	1900	1827	1827	1900	1845	1845	1845
Adj Flow Rate, veh/h	312	264	106	18	441	55	255	525	36	47	360	296
Adj No. of Lanes	1	2	0	1	2	0	1	2	0	1	2	1
Peak Hour Factor	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96
Percent Heavy Veh, %	3	3	3	3	3	3	4	4	4	3	3	3
Cap, veh/h	434	1076	421	292	633	79	411	1386	95	284	811	613
Arrive On Green	0.16	0.44	0.44	0.20	0.20	0.20	0.04	0.14	0.14	0.46	0.46	0.46
Sat Flow, veh/h	1757	2463	964	998	3139	390	1740	3297	226	837	3505	1568
Grp Volume(v), veh/h	312	186	184	18	245	251	255	276	285	47	360	296
Grp Sat Flow(s),veh/h/ln	1757	1752	1675	998	1752	1776	1740	1736	1787	837	1752	1568
Q Serve(g_s), s	10.5	5.3	5.5	1.2	10.3	10.4	8.4	11.5	11.5	2.7	5.5	10.2
Cycle Q Clear(g_c), s	10.5	5.3	5.5	1.2	10.3	10.4	8.4	11.5	11.5	2.7	5.5	10.2
Prop In Lane	1.00		0.58	1.00		0.22	1.00		0.13	1.00		1.00
Lane Grp Cap(c), veh/h	434	766	732	292	353	358	411	730	751	284	811	613
V/C Ratio(X)	0.72	0.24	0.25	0.06	0.69	0.70	0.62	0.38	0.38	0.17	0.44	0.48
Avail Cap(c_a), veh/h	463	795	760	292	353	358	411	730	751	284	811	613
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	0.33	0.33	0.33	2.00	2.00	2.00
Upstream Filter(I)	0.88	0.88	0.88	0.97	0.97	0.97	0.96	0.96	0.96	0.98	0.98	0.98
Uniform Delay (d), s/veh	19.6	14.1	14.1	25.7	29.4	29.4	20.6	24.7	24.8	17.1	17.9	12.5
Incr Delay (d2), s/veh	4.4	0.1	0.2	0.1	5.6	5.8	2.7	1.4	1.4	1.2	1.7	2.7
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	5.5	2.6	2.6	0.3	5.5	5.7	4.3	5.8	6.0	0.7	2.8	4.7
LnGrp Delay(d),s/veh	24.0	14.2	14.3	25.8	35.0	35.2	23.3	26.2	26.2	18.3	19.6	15.1
LnGrp LOS	C	B	B	C	D	D	C	C	C	B	B	B
Approach Vol, veh/h		682			514			816			703	
Approach Delay, s/veh		18.7			34.8			25.3			17.6	
Approach LOS		B			C			C			B	

Timer	1	2	3	4	5	6	7	8
Assigned Phs	1	2	3	4		6		8
Phs Duration (G+Y+Rc), s	15.0	24.3	18.7	22.0		39.3		40.7
Change Period (Y+Rc), s	6.0	6.0	6.0	6.0		6.0		6.0
Max Green Setting (Gmax), s	9.0	17.0	14.0	16.0		32.0		36.0
Max Q Clear Time (g_c+I1), s	10.4	12.2	12.5	12.4		13.5		7.5
Green Ext Time (p_c), s	0.0	2.8	0.2	1.7		6.9		5.7

Intersection Summary	
HCM 2010 Ctrl Delay	23.5
HCM 2010 LOS	C

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	8	38	111	14	35	66	25	198	15	51	431	22
Number	3	8	18	7	4	14	1	6	16	5	2	12
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1900	1792	1900	1900	1759	1900	1776	1776	1900	1810	1810	1810
Adj Flow Rate, veh/h	9	41	121	15	38	72	27	215	16	55	468	24
Adj No. of Lanes	0	1	0	0	1	0	1	2	0	1	2	1
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Percent Heavy Veh, %	6	6	6	8	8	8	7	7	7	5	5	5
Cap, veh/h	57	90	235	71	121	188	545	1671	123	780	2354	1053
Arrive On Green	0.21	0.21	0.21	0.21	0.21	0.21	0.52	0.52	0.52	0.03	0.23	0.23
Sat Flow, veh/h	32	430	1118	85	575	897	859	3186	235	1723	3438	1538
Grp Volume(v), veh/h	171	0	0	125	0	0	27	113	118	55	468	24
Grp Sat Flow(s),veh/h/ln	1581	0	0	1556	0	0	859	1687	1734	1723	1719	1538
Q Serve(g_s), s	0.0	0.0	0.0	0.0	0.0	0.0	1.2	2.6	2.6	1.0	8.4	0.9
Cycle Q Clear(g_c), s	7.2	0.0	0.0	5.1	0.0	0.0	1.2	2.6	2.6	1.0	8.4	0.9
Prop In Lane	0.05		0.71	0.12		0.58	1.00		0.14	1.00		1.00
Lane Grp Cap(c), veh/h	382	0	0	380	0	0	545	885	909	780	2354	1053
V/C Ratio(X)	0.45	0.00	0.00	0.33	0.00	0.00	0.05	0.13	0.13	0.07	0.20	0.02
Avail Cap(c_a), veh/h	547	0	0	540	0	0	545	885	909	934	2354	1053
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.33	0.33	0.33
Upstream Filter(I)	1.00	0.00	0.00	1.00	0.00	0.00	1.00	1.00	1.00	0.91	0.91	0.91
Uniform Delay (d), s/veh	26.6	0.0	0.0	25.7	0.0	0.0	8.9	9.2	9.2	5.8	12.5	9.6
Incr Delay (d2), s/veh	0.8	0.0	0.0	0.5	0.0	0.0	0.2	0.3	0.3	0.0	0.2	0.0
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	3.3	0.0	0.0	2.3	0.0	0.0	0.3	1.3	1.3	0.5	4.1	0.4
LnGrp Delay(d),s/veh	27.4	0.0	0.0	26.2	0.0	0.0	9.0	9.5	9.5	5.8	12.7	9.7
LnGrp LOS	C			C			A	A	A	A	B	A
Approach Vol, veh/h		171			125			258			547	
Approach Delay, s/veh		27.4			26.2			9.5			11.9	
Approach LOS		C			C			A			B	

Timer	1	2	3	4	5	6	7	8
Assigned Phs		2		4	5	6		8
Phs Duration (G+Y+Rc), s		58.0		22.0	12.2	45.8		22.0
Change Period (Y+Rc), s		6.0		6.0	6.0	6.0		6.0
Max Green Setting (Gmax), s		44.0		24.0	13.0	25.0		24.0
Max Q Clear Time (g_c+I1), s		10.4		7.1	3.0	4.6		9.2
Green Ext Time (p_c), s		5.1		1.7	0.1	4.6		1.6

Intersection Summary	
HCM 2010 Ctrl Delay	15.3
HCM 2010 LOS	B

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	57	50	45	12	61	149	68	502	23	84	255	52
Number	3	8	18	7	4	14	1	6	16	5	2	12
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1900	1863	1900	1900	1776	1900	1827	1827	1900	1863	1863	1863
Adj Flow Rate, veh/h	58	51	46	12	62	152	69	512	23	86	260	53
Adj No. of Lanes	0	1	0	0	1	0	1	2	0	1	2	1
Peak Hour Factor	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98	0.98
Percent Heavy Veh, %	2	2	2	7	7	7	4	4	4	2	2	2
Cap, veh/h	154	132	93	57	100	221	618	1701	76	628	2406	1076
Arrive On Green	0.21	0.21	0.21	0.21	0.21	0.21	0.50	0.50	0.50	0.03	0.22	0.22
Sat Flow, veh/h	427	630	446	36	480	1058	1042	3384	152	1774	3539	1583
Grp Volume(v), veh/h	155	0	0	226	0	0	69	262	273	86	260	53
Grp Sat Flow(s),veh/h/ln	1504	0	0	1573	0	0	1042	1736	1800	1774	1770	1583
Q Serve(g_s), s	0.0	0.0	0.0	1.0	0.0	0.0	2.7	6.8	6.8	1.5	4.5	2.0
Cycle Q Clear(g_c), s	6.5	0.0	0.0	10.1	0.0	0.0	2.7	6.8	6.8	1.5	4.5	2.0
Prop In Lane	0.37		0.30	0.05		0.67	1.00		0.08	1.00		1.00
Lane Grp Cap(c), veh/h	379	0	0	379	0	0	618	872	905	628	2406	1076
V/C Ratio(X)	0.41	0.00	0.00	0.60	0.00	0.00	0.11	0.30	0.30	0.14	0.11	0.05
Avail Cap(c_a), veh/h	513	0	0	521	0	0	618	872	905	708	2406	1076
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.33	0.33	0.33
Upstream Filter(I)	1.00	0.00	0.00	0.99	0.00	0.00	1.00	1.00	1.00	0.89	0.89	0.89
Uniform Delay (d), s/veh	26.3	0.0	0.0	27.9	0.0	0.0	10.1	11.1	11.2	6.6	11.2	10.3
Incr Delay (d2), s/veh	0.7	0.0	0.0	1.5	0.0	0.0	0.4	0.9	0.9	0.1	0.1	0.1
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	3.0	0.0	0.0	4.6	0.0	0.0	0.8	3.4	3.5	0.7	2.2	0.9
LnGrp Delay(d),s/veh	27.1	0.0	0.0	29.4	0.0	0.0	10.5	12.0	12.0	6.7	11.3	10.4
LnGrp LOS	C			C			B	B	B	A	B	B
Approach Vol, veh/h		155			226			604			399	
Approach Delay, s/veh		27.1			29.4			11.8			10.2	
Approach LOS		C			C			B			B	

Timer	1	2	3	4	5	6	7	8
Assigned Phs		2		4	5	6		8
Phs Duration (G+Y+Rc), s		58.0		22.0	13.6	44.5		22.0
Change Period (Y+Rc), s		6.0		6.0	6.0	6.0		6.0
Max Green Setting (Gmax), s		45.0		23.0	11.0	28.0		23.0
Max Q Clear Time (g_c+I1), s		6.5		12.1	3.5	8.8		8.5
Green Ext Time (p_c), s		6.1		1.9	0.1	5.2		2.2

Intersection Summary	
HCM 2010 Ctrl Delay	15.9
HCM 2010 LOS	B

Intersection	
Int Delay, s/veh	2.1

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Vol, veh/h	0	196	88	15	309	293
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	-	0	-	-	250	-
Veh in Median Storage, #	0	-	0	-	-	0
Grade, %	0	-	0	-	-	0
Peak Hour Factor	88	88	88	88	88	88
Heavy Vehicles, %	2	2	7	7	3	3
Mvmt Flow	0	223	100	17	351	333

Major/Minor	Minor1		Major1		Major2	
Conflicting Flow All	978	59	0	0	117	0
Stage 1	109	-	-	-	-	-
Stage 2	869	-	-	-	-	-
Critical Hdwy	6.84	6.94	-	-	4.16	-
Critical Hdwy Stg 1	5.84	-	-	-	-	-
Critical Hdwy Stg 2	5.84	-	-	-	-	-
Follow-up Hdwy	3.52	3.32	-	-	2.23	-
Pot Cap-1 Maneuver	248	994	-	-	1462	-
Stage 1	903	-	-	-	-	-
Stage 2	371	-	-	-	-	-
Platoon blocked, %			-	-		-
Mov Cap-1 Maneuver	188	994	-	-	1462	-
Mov Cap-2 Maneuver	247	-	-	-	-	-
Stage 1	903	-	-	-	-	-
Stage 2	282	-	-	-	-	-

Approach	WB	NB	SB
HCM Control Delay, s	9.7		
HCM LOS	A		

Minor Lane/Major Mvmt	NBT	NBR	WBLn1	SBL	SBT
Capacity (veh/h)	-	-	994	1462	-
HCM Lane V/C Ratio	-	-	0.224	0.24	-
HCM Control Delay (s)	-	-	9.7	8.2	-
HCM Lane LOS	-	-	A	A	-
HCM 95th %tile Q(veh)	-	-	1	1	-

Intersection	
Int Delay, s/veh	4.3

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Vol, veh/h	0	337	257	23	227	107
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	-	0	-	-	250	-
Veh in Median Storage, #	0	-	0	-	-	0
Grade, %	0	-	0	-	-	0
Peak Hour Factor	95	95	95	95	95	95
Heavy Vehicles, %	8	8	4	4	4	4
Mvmt Flow	0	355	271	24	239	113

Major/Minor	Minor1		Major1		Major2	
Conflicting Flow All	817	147	0	0	295	0
Stage 1	283	-	-	-	-	-
Stage 2	534	-	-	-	-	-
Critical Hdwy	6.96	7.06	-	-	4.18	-
Critical Hdwy Stg 1	5.96	-	-	-	-	-
Critical Hdwy Stg 2	5.96	-	-	-	-	-
Follow-up Hdwy	3.58	3.38	-	-	2.24	-
Pot Cap-1 Maneuver	303	855	-	-	1249	-
Stage 1	722	-	-	-	-	-
Stage 2	535	-	-	-	-	-
Platoon blocked, %			-	-		-
Mov Cap-1 Maneuver	245	855	-	-	1249	-
Mov Cap-2 Maneuver	347	-	-	-	-	-
Stage 1	722	-	-	-	-	-
Stage 2	433	-	-	-	-	-

Approach	WB	NB	SB
HCM Control Delay, s	12.2		
HCM LOS	B		

Minor Lane/Major Mvmt	NBT	NBR	WBLn1	SBL	SBT
Capacity (veh/h)	-	-	855	1249	-
HCM Lane V/C Ratio	-	-	0.415	0.191	-
HCM Control Delay (s)	-	-	12.2	8.6	-
HCM Lane LOS	-	-	B	A	-
HCM 95th %tile Q(veh)	-	-	2	1	-

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	4	150	4	15	10	23	4	83	10	150	161	7
Number	3	8	18	7	4	14	1	6	16	5	2	12
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1900	1810	1900	1900	1863	1863	1681	1681	1681	1863	1863	1900
Adj Flow Rate, veh/h	4	160	4	16	11	24	4	88	11	160	171	7
Adj No. of Lanes	0	1	0	0	1	1	1	1	1	1	1	0
Peak Hour Factor	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94
Percent Heavy Veh, %	5	5	5	2	2	2	13	13	13	2	2	2
Cap, veh/h	90	604	15	406	247	548	501	628	534	606	664	27
Arrive On Green	0.35	0.35	0.35	0.35	0.35	0.35	0.37	0.37	0.37	0.37	0.37	0.37
Sat Flow, veh/h	11	1744	43	785	713	1583	1084	1681	1429	1291	1777	73
Grp Volume(v), veh/h	168	0	0	27	0	24	4	88	11	160	0	178
Grp Sat Flow(s),veh/h/ln	1798	0	0	1498	0	1583	1084	1681	1429	1291	0	1850
Q Serve(g_s), s	0.0	0.0	0.0	0.0	0.0	0.4	0.1	1.5	0.2	4.0	0.0	2.9
Cycle Q Clear(g_c), s	2.9	0.0	0.0	0.4	0.0	0.4	3.0	1.5	0.2	5.5	0.0	2.9
Prop In Lane	0.02		0.02	0.59		1.00	1.00		1.00	1.00		0.04
Lane Grp Cap(c), veh/h	708	0	0	652	0	548	501	628	534	606	0	691
V/C Ratio(X)	0.24	0.00	0.00	0.04	0.00	0.04	0.01	0.14	0.02	0.26	0.00	0.26
Avail Cap(c_a), veh/h	758	0	0	691	0	592	704	942	801	847	0	1037
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	0.00	0.00	1.00	0.00	1.00	1.00	1.00	1.00	1.00	0.00	1.00
Uniform Delay (d), s/veh	10.1	0.0	0.0	9.3	0.0	9.3	10.3	8.9	8.5	10.7	0.0	9.3
Incr Delay (d2), s/veh	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.2	0.0	0.2
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	1.4	0.0	0.0	0.2	0.0	0.2	0.0	0.7	0.1	1.5	0.0	1.5
LnGrp Delay(d),s/veh	10.3	0.0	0.0	9.3	0.0	9.3	10.3	9.0	8.5	10.9	0.0	9.5
LnGrp LOS	B			A		A	B	A	A	B		A
Approach Vol, veh/h		168			51			103			338	
Approach Delay, s/veh		10.3			9.3			9.0			10.2	
Approach LOS		B			A			A			B	

Timer	1	2	3	4	5	6	7	8
Assigned Phs		2		4		6		8
Phs Duration (G+Y+Rc), s		22.0		20.8		22.0		20.8
Change Period (Y+Rc), s		6.0		6.0		6.0		6.0
Max Green Setting (Gmax), s		24.0		16.0		24.0		16.0
Max Q Clear Time (g_c+I1), s		7.5		2.4		5.0		4.9
Green Ext Time (p_c), s		1.8		1.0		1.9		0.8

Intersection Summary	
HCM 2010 Ctrl Delay	9.9
HCM 2010 LOS	A

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	5	10	4	14	91	104	4	249	12	43	223	4
Number	3	8	18	7	4	14	1	6	16	5	2	12
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1900	1863	1900	1900	1845	1845	1845	1845	1845	1827	1827	1900
Adj Flow Rate, veh/h	6	11	4	16	102	117	4	280	13	48	251	4
Adj No. of Lanes	0	1	0	0	1	1	1	1	1	1	1	0
Peak Hour Factor	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89	0.89
Percent Heavy Veh, %	2	2	2	3	3	3	3	3	3	4	4	4
Cap, veh/h	215	354	109	132	601	553	463	682	580	439	663	11
Arrive On Green	0.35	0.35	0.35	0.35	0.35	0.35	0.37	0.37	0.37	0.37	0.37	0.37
Sat Flow, veh/h	307	1005	309	105	1704	1568	1109	1845	1568	1061	1793	29
Grp Volume(v), veh/h	21	0	0	118	0	117	4	280	13	48	0	255
Grp Sat Flow(s),veh/h/ln	1621	0	0	1809	0	1568	1109	1845	1568	1061	0	1822
Q Serve(g_s), s	0.0	0.0	0.0	0.0	0.0	2.3	0.1	4.9	0.2	1.5	0.0	4.4
Cycle Q Clear(g_c), s	0.3	0.0	0.0	1.9	0.0	2.3	4.6	4.9	0.2	6.4	0.0	4.4
Prop In Lane	0.29		0.19	0.14		1.00	1.00		1.00	1.00		0.02
Lane Grp Cap(c), veh/h	679	0	0	733	0	553	463	682	580	439	0	674
V/C Ratio(X)	0.03	0.00	0.00	0.16	0.00	0.21	0.01	0.41	0.02	0.11	0.00	0.38
Avail Cap(c_a), veh/h	705	0	0	763	0	580	668	1023	870	635	0	1011
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	0.00	0.00	1.00	0.00	1.00	1.00	1.00	1.00	1.00	0.00	1.00
Uniform Delay (d), s/veh	9.2	0.0	0.0	9.7	0.0	9.8	11.7	10.1	8.7	12.5	0.0	10.0
Incr Delay (d2), s/veh	0.0	0.0	0.0	0.1	0.0	0.2	0.0	0.4	0.0	0.1	0.0	0.4
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	0.2	0.0	0.0	1.0	0.0	1.0	0.0	2.6	0.1	0.5	0.0	2.3
LnGrp Delay(d),s/veh	9.2	0.0	0.0	9.8	0.0	10.0	11.7	10.5	8.7	12.6	0.0	10.3
LnGrp LOS	A			A		A	B	B	A	B		B
Approach Vol, veh/h		21			235			297			303	
Approach Delay, s/veh		9.2			9.9			10.5			10.7	
Approach LOS		A			A			B			B	

Timer	1	2	3	4	5	6	7	8
Assigned Phs		2		4		6		8
Phs Duration (G+Y+Rc), s		22.0		21.3		22.0		21.3
Change Period (Y+Rc), s		6.0		6.0		6.0		6.0
Max Green Setting (Gmax), s		24.0		16.0		24.0		16.0
Max Q Clear Time (g_c+I1), s		8.4		4.3		6.9		2.3
Green Ext Time (p_c), s		3.0		0.9		3.1		1.0

Intersection Summary	
HCM 2010 Ctrl Delay	10.4
HCM 2010 LOS	B

Intersection	
Int Delay, s/veh	2

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Vol, veh/h	4	92	62	104	194	4
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	Yield	-	None	-	Yield
Storage Length	50	0	175	-	-	-
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	96	96	96	96	96	96
Heavy Vehicles, %	2	2	7	7	7	7
Mvmt Flow	4	96	65	108	202	4

Major/Minor	Minor2		Major1		Major2	
Conflicting Flow All	385	101	202	0	-	0
Stage 1	202	-	-	-	-	-
Stage 2	183	-	-	-	-	-
Critical Hdwy	6.84	6.94	4.24	-	-	-
Critical Hdwy Stg 1	5.84	-	-	-	-	-
Critical Hdwy Stg 2	5.84	-	-	-	-	-
Follow-up Hdwy	3.52	3.32	2.27	-	-	-
Pot Cap-1 Maneuver	591	935	1331	-	-	-
Stage 1	812	-	-	-	-	-
Stage 2	830	-	-	-	-	-
Platoon blocked, %				-	-	-
Mov Cap-1 Maneuver	562	935	1331	-	-	-
Mov Cap-2 Maneuver	562	-	-	-	-	-
Stage 1	812	-	-	-	-	-
Stage 2	789	-	-	-	-	-

Approach	EB	NB	SB
HCM Control Delay, s	9.4		
HCM LOS	A		

Minor Lane/Major Mvmt	NBL	NBT	EBLn1	EBLn2	SBT	SBR
Capacity (veh/h)	1331	-	562	935	-	-
HCM Lane V/C Ratio	0.049	-	0.007	0.102	-	-
HCM Control Delay (s)	7.8	-	11.5	9.3	-	-
HCM Lane LOS	A	-	B	A	-	-
HCM 95th %tile Q(veh)	0	-	0	0	-	-

Intersection	
Int Delay, s/veh	1

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Vol, veh/h	4	62	99	208	230	4
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	Yield	-	None	-	Yield
Storage Length	50	0	175	-	-	-
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	96	96	96	96	96	96
Heavy Vehicles, %	2	2	3	3	3	3
Mvmt Flow	4	65	103	217	240	4

Major/Minor	Minor2		Major1		Major2	
Conflicting Flow All	555	120	240	0	-	0
Stage 1	240	-	-	-	-	-
Stage 2	315	-	-	-	-	-
Critical Hdwy	6.84	6.94	4.16	-	-	-
Critical Hdwy Stg 1	5.84	-	-	-	-	-
Critical Hdwy Stg 2	5.84	-	-	-	-	-
Follow-up Hdwy	3.52	3.32	2.23	-	-	-
Pot Cap-1 Maneuver	462	909	1317	-	-	-
Stage 1	777	-	-	-	-	-
Stage 2	713	-	-	-	-	-
Platoon blocked, %				-	-	-
Mov Cap-1 Maneuver	426	909	1317	-	-	-
Mov Cap-2 Maneuver	426	-	-	-	-	-
Stage 1	777	-	-	-	-	-
Stage 2	657	-	-	-	-	-

Approach	EB	NB	SB
HCM Control Delay, s	9.6		
HCM LOS	A		

Minor Lane/Major Mvmt	NBL	NBT	EBLn1	EBLn2	SBT	SBR
Capacity (veh/h)	1317	-	426	909	-	-
HCM Lane V/C Ratio	0.078	-	0.01	0.071	-	-
HCM Control Delay (s)	8	-	13.5	9.3	-	-
HCM Lane LOS	A	-	B	A	-	-
HCM 95th %tile Q(veh)	0	-	0	0	-	-

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	4	142	28	9	62	7	15	45	4	11	83	7
Number	5	2	12	1	6	16	3	8	18	7	4	14
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1743	1743	1900	1727	1727	1900	1845	1845	1900	1863	1863	1900
Adj Flow Rate, veh/h	4	154	30	10	67	8	16	49	4	12	90	8
Adj No. of Lanes	1	1	0	1	1	0	1	1	0	1	1	0
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Percent Heavy Veh, %	9	9	9	10	10	10	3	3	3	2	2	2
Cap, veh/h	347	171	33	218	469	56	313	232	19	350	233	21
Arrive On Green	0.12	0.12	0.12	0.00	0.31	0.31	0.14	0.14	0.14	0.14	0.14	0.14
Sat Flow, veh/h	1234	1418	276	1645	1515	181	1279	1683	137	1346	1686	150
Grp Volume(v), veh/h	4	0	184	10	0	75	16	0	53	12	0	98
Grp Sat Flow(s),veh/h/ln	1234	0	1694	1645	0	1695	1279	0	1820	1346	0	1836
Q Serve(g_s), s	0.1	0.0	3.9	0.1	0.0	1.2	0.4	0.0	0.9	0.3	0.0	1.8
Cycle Q Clear(g_c), s	0.1	0.0	3.9	0.1	0.0	1.2	2.2	0.0	0.9	1.2	0.0	1.8
Prop In Lane	1.00		0.16	1.00		0.11	1.00		0.08	1.00		0.08
Lane Grp Cap(c), veh/h	347	0	204	218	0	525	313	0	251	350	0	253
V/C Ratio(X)	0.01	0.00	0.90	0.05	0.00	0.14	0.05	0.00	0.21	0.03	0.00	0.39
Avail Cap(c_a), veh/h	983	0	1076	531	0	1872	560	0	603	610	0	608
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00	1.00
Uniform Delay (d), s/veh	14.1	0.0	15.7	15.0	0.0	9.0	15.2	0.0	13.9	14.4	0.0	14.2
Incr Delay (d2), s/veh	0.0	0.0	13.4	0.1	0.0	0.1	0.1	0.0	0.4	0.0	0.0	1.0
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	0.0	0.0	2.6	0.1	0.0	0.6	0.2	0.0	0.5	0.1	0.0	1.0
LnGrp Delay(d),s/veh	14.1	0.0	29.2	15.1	0.0	9.1	15.3	0.0	14.3	14.4	0.0	15.2
LnGrp LOS	B		C	B		A	B		B	B		B
Approach Vol, veh/h		188			85			69			110	
Approach Delay, s/veh		28.8			9.9			14.5			15.1	
Approach LOS		C			A			B			B	

Timer	1	2	3	4	5	6	7	8
Assigned Phs	1	2		4		6		8
Phs Duration (G+Y+Rc), s	6.9	14.4		15.0		21.2		15.0
Change Period (Y+Rc), s	6.0	6.0		6.0		6.0		6.0
Max Green Setting (Gmax), s	11.0	27.0		16.0		44.0		16.0
Max Q Clear Time (g_c+I1), s	2.1	5.9		3.8		3.2		4.2
Green Ext Time (p_c), s	0.0	1.4		0.6		1.7		0.6

Intersection Summary	
HCM 2010 Ctrl Delay	19.7
HCM 2010 LOS	B

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	6	93	37	35	169	15	44	107	4	5	37	4
Number	5	2	12	1	6	16	3	8	18	7	4	14
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1845	1845	1900	1863	1863	1900	1827	1827	1900	1863	1863	1900
Adj Flow Rate, veh/h	7	109	44	41	199	18	52	126	5	6	44	5
Adj No. of Lanes	1	1	0	1	1	0	1	1	0	1	1	0
Peak Hour Factor	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85	0.85
Percent Heavy Veh, %	3	3	3	2	2	2	4	4	4	2	2	2
Cap, veh/h	444	283	114	519	779	70	461	402	16	398	378	43
Arrive On Green	0.23	0.23	0.23	0.08	0.46	0.46	0.23	0.23	0.23	0.23	0.23	0.23
Sat Flow, veh/h	1148	1251	505	1774	1684	152	1325	1745	69	1254	1643	187
Grp Volume(v), veh/h	7	0	153	41	0	217	52	0	131	6	0	49
Grp Sat Flow(s),veh/h/ln	1148	0	1756	1774	0	1836	1325	0	1815	1254	0	1830
Q Serve(g_s), s	0.2	0.0	2.9	0.6	0.0	2.8	1.3	0.0	2.3	0.2	0.0	0.8
Cycle Q Clear(g_c), s	0.2	0.0	2.9	0.6	0.0	2.8	2.1	0.0	2.3	2.5	0.0	0.8
Prop In Lane	1.00		0.29	1.00		0.08	1.00		0.04	1.00		0.10
Lane Grp Cap(c), veh/h	444	0	398	519	0	849	461	0	418	398	0	421
V/C Ratio(X)	0.02	0.00	0.38	0.08	0.00	0.26	0.11	0.00	0.31	0.02	0.00	0.12
Avail Cap(c_a), veh/h	1036	0	1303	780	0	2067	698	0	743	622	0	749
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00	1.00
Uniform Delay (d), s/veh	11.8	0.0	12.8	8.5	0.0	6.4	12.7	0.0	12.5	13.5	0.0	11.9
Incr Delay (d2), s/veh	0.0	0.0	0.6	0.1	0.0	0.2	0.1	0.0	0.4	0.0	0.0	0.1
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	0.1	0.0	1.5	0.3	0.0	1.4	0.5	0.0	1.2	0.1	0.0	0.4
LnGrp Delay(d),s/veh	11.8	0.0	13.4	8.6	0.0	6.6	12.8	0.0	12.9	13.5	0.0	12.0
LnGrp LOS	B		B	A		A	B		B	B		B
Approach Vol, veh/h		160			258			183			55	
Approach Delay, s/veh		13.3			6.9			12.9			12.2	
Approach LOS		B			A			B			B	

Timer	1	2	3	4	5	6	7	8
Assigned Phs	1	2		4		6		8
Phs Duration (G+Y+Rc), s	9.2	14.8		15.0		24.1		15.0
Change Period (Y+Rc), s	6.0	6.0		6.0		6.0		6.0
Max Green Setting (Gmax), s	9.0	29.0		16.0		44.0		16.0
Max Q Clear Time (g_c+I1), s	2.6	4.9		4.5		4.8		4.3
Green Ext Time (p_c), s	0.0	2.2		0.8		2.4		0.8

Intersection Summary	
HCM 2010 Ctrl Delay	10.6
HCM 2010 LOS	B

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	76	279	57	94	118	15	51	276	160	43	411	84
Number	3	8	18	7	4	14	1	6	16	5	2	12
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1810	1810	1900	1776	1776	1900	1827	1827	1900	1827	1827	1827
Adj Flow Rate, veh/h	78	288	59	97	122	15	53	285	165	44	424	87
Adj No. of Lanes	1	2	0	1	2	0	1	1	0	1	1	1
Peak Hour Factor	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97
Percent Heavy Veh, %	5	5	5	7	7	7	4	4	4	4	4	4
Cap, veh/h	519	949	192	402	1009	122	359	453	263	343	762	648
Arrive On Green	0.33	0.33	0.33	0.33	0.33	0.33	0.42	0.42	0.42	0.42	0.42	0.42
Sat Flow, veh/h	1211	2851	576	981	3031	367	868	1087	629	919	1827	1553
Grp Volume(v), veh/h	78	172	175	97	67	70	53	0	450	44	424	87
Grp Sat Flow(s),veh/h/ln	1211	1719	1708	981	1687	1711	868	0	1716	919	1827	1553
Q Serve(g_s), s	2.3	3.6	3.7	3.9	1.3	1.4	2.4	0.0	10.0	1.9	8.5	1.7
Cycle Q Clear(g_c), s	3.7	3.6	3.7	7.6	1.3	1.4	10.8	0.0	10.0	11.9	8.5	1.7
Prop In Lane	1.00		0.34	1.00		0.21	1.00		0.37	1.00		1.00
Lane Grp Cap(c), veh/h	519	572	569	402	562	570	359	0	716	343	762	648
V/C Ratio(X)	0.15	0.30	0.31	0.24	0.12	0.12	0.15	0.00	0.63	0.13	0.56	0.13
Avail Cap(c_a), veh/h	519	572	569	402	562	570	611	0	1214	610	1293	1099
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.00	1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	12.4	11.9	11.9	14.7	11.1	11.1	14.7	0.0	11.1	15.7	10.6	8.6
Incr Delay (d2), s/veh	0.1	0.3	0.3	0.3	0.1	0.1	0.2	0.0	0.9	0.2	0.6	0.1
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	0.8	1.7	1.7	1.1	0.6	0.7	0.6	0.0	4.8	0.5	4.4	0.7
LnGrp Delay(d),s/veh	12.6	12.2	12.2	15.0	11.2	11.2	14.9	0.0	12.0	15.9	11.3	8.7
LnGrp LOS	B	B	B	B	B	B	B		B	B	B	A
Approach Vol, veh/h		425			234			503			555	
Approach Delay, s/veh		12.3			12.8			12.3			11.2	
Approach LOS		B			B			B			B	

Timer	1	2	3	4	5	6	7	8
Assigned Phs		2		4		6		8
Phs Duration (G+Y+Rc), s		26.0		22.0		26.0		22.0
Change Period (Y+Rc), s		6.0		6.0		6.0		6.0
Max Green Setting (Gmax), s		34.0		16.0		34.0		16.0
Max Q Clear Time (g_c+I1), s		13.9		9.6		12.8		5.7
Green Ext Time (p_c), s		6.2		2.0		6.3		2.7

Intersection Summary	
HCM 2010 Ctrl Delay	12.0
HCM 2010 LOS	B

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	74	128	61	146	343	72	122	482	90	9	300	91
Number	3	8	18	7	4	14	1	6	16	5	2	12
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1845	1845	1900	1863	1863	1900	1863	1863	1900	1863	1863	1863
Adj Flow Rate, veh/h	81	141	67	160	377	79	134	530	99	10	330	100
Adj No. of Lanes	1	2	0	1	2	0	1	1	0	1	1	1
Peak Hour Factor	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91
Percent Heavy Veh, %	3	3	3	2	2	2	2	2	2	2	2	2
Cap, veh/h	327	722	327	444	898	186	468	705	132	278	860	731
Arrive On Green	0.31	0.31	0.31	0.31	0.31	0.31	0.46	0.46	0.46	0.46	0.46	0.46
Sat Flow, veh/h	922	2347	1063	1169	2920	606	954	1527	285	794	1863	1583
Grp Volume(v), veh/h	81	104	104	160	227	229	134	0	629	10	330	100
Grp Sat Flow(s),veh/h/ln	922	1752	1657	1169	1770	1756	954	0	1812	794	1863	1583
Q Serve(g_s), s	4.0	2.3	2.4	6.1	5.3	5.4	5.6	0.0	14.9	0.5	6.0	1.9
Cycle Q Clear(g_c), s	9.4	2.3	2.4	8.5	5.3	5.4	11.6	0.0	14.9	15.4	6.0	1.9
Prop In Lane	1.00		0.64	1.00		0.35	1.00		0.16	1.00		1.00
Lane Grp Cap(c), veh/h	327	539	510	444	544	540	468	0	837	278	860	731
V/C Ratio(X)	0.25	0.19	0.20	0.36	0.42	0.42	0.29	0.00	0.75	0.04	0.38	0.14
Avail Cap(c_a), veh/h	327	539	510	444	544	540	652	0	1185	430	1218	1035
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.00	1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	18.1	13.2	13.3	16.4	14.3	14.3	13.0	0.0	11.5	17.9	9.2	8.0
Incr Delay (d2), s/veh	0.4	0.2	0.2	0.5	0.5	0.5	0.3	0.0	1.7	0.1	0.3	0.1
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	1.0	1.1	1.1	2.0	2.7	2.7	1.5	0.0	7.7	0.1	3.1	0.8
LnGrp Delay(d),s/veh	18.5	13.4	13.5	16.9	14.8	14.9	13.3	0.0	13.2	18.0	9.4	8.1
LnGrp LOS	B	B	B	B	B	B	B		B	B	A	A
Approach Vol, veh/h		289			616			763			440	
Approach Delay, s/veh		14.9			15.4			13.3			9.3	
Approach LOS		B			B			B			A	

Timer	1	2	3	4	5	6	7	8
Assigned Phs		2		4		6		8
Phs Duration (G+Y+Rc), s		30.0		22.0		30.0		22.0
Change Period (Y+Rc), s		6.0		6.0		6.0		6.0
Max Green Setting (Gmax), s		34.0		16.0		34.0		16.0
Max Q Clear Time (g_c+I1), s		17.4		10.5		16.9		11.4
Green Ext Time (p_c), s		6.6		2.4		6.7		2.1

Intersection Summary	
HCM 2010 Ctrl Delay	13.3
HCM 2010 LOS	B

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	255	153	75	4	38	4	30	224	4	4	414	148
Number	3	8	18	7	4	14	1	6	16	5	2	12
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1845	1845	1900	1681	1681	1900	1759	1759	1900	1810	1810	1810
Adj Flow Rate, veh/h	266	159	78	4	40	4	31	233	4	4	431	154
Adj No. of Lanes	1	2	0	1	2	0	1	1	0	1	1	1
Peak Hour Factor	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96
Percent Heavy Veh, %	3	3	3	13	13	13	8	8	8	5	5	5
Cap, veh/h	632	832	390	480	1055	104	298	641	11	464	672	571
Arrive On Green	0.36	0.36	0.36	0.36	0.36	0.36	0.37	0.37	0.37	0.37	0.37	0.37
Sat Flow, veh/h	1344	2319	1086	1028	2938	289	781	1724	30	1106	1810	1538
Grp Volume(v), veh/h	266	118	119	4	21	23	31	0	237	4	431	154
Grp Sat Flow(s),veh/h/ln	1344	1752	1653	1028	1597	1630	781	0	1754	1106	1810	1538
Q Serve(g_s), s	7.1	2.1	2.2	0.1	0.4	0.4	1.5	0.0	4.4	0.1	8.7	3.1
Cycle Q Clear(g_c), s	7.5	2.1	2.2	2.3	0.4	0.4	10.3	0.0	4.4	4.5	8.7	3.1
Prop In Lane	1.00		0.66	1.00		0.18	1.00		0.02	1.00		1.00
Lane Grp Cap(c), veh/h	632	629	593	480	573	585	298	0	652	464	672	571
V/C Ratio(X)	0.42	0.19	0.20	0.01	0.04	0.04	0.10	0.00	0.36	0.01	0.64	0.27
Avail Cap(c_a), veh/h	723	748	705	549	682	696	517	0	1142	774	1179	1002
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.00	1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	11.7	9.8	9.9	10.7	9.3	9.3	15.8	0.0	10.2	11.8	11.5	9.8
Incr Delay (d2), s/veh	0.4	0.1	0.2	0.0	0.0	0.0	0.2	0.0	0.3	0.0	1.0	0.3
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	2.7	1.0	1.0	0.0	0.2	0.2	0.3	0.0	2.2	0.0	4.5	1.4
LnGrp Delay(d),s/veh	12.2	10.0	10.0	10.7	9.3	9.3	15.9	0.0	10.5	11.8	12.6	10.0
LnGrp LOS	B	A	B	B	A	A	B		B	B	B	B
Approach Vol, veh/h		503			48			268			589	
Approach Delay, s/veh		11.1			9.4			11.1			11.9	
Approach LOS		B			A			B			B	

Timer	1	2	3	4	5	6	7	8
Assigned Phs		2		4		6		8
Phs Duration (G+Y+Rc), s		22.5		22.0		22.5		22.0
Change Period (Y+Rc), s		6.0		6.0		6.0		6.0
Max Green Setting (Gmax), s		29.0		19.0		29.0		19.0
Max Q Clear Time (g_c+I1), s		10.7		4.3		12.3		9.5
Green Ext Time (p_c), s		4.4		2.1		4.3		1.7

Intersection Summary	
HCM 2010 Ctrl Delay	11.4
HCM 2010 LOS	B

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	214	25	35	16	86	4	108	468	4	4	255	255
Number	3	8	18	7	4	14	1	6	16	5	2	12
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1863	1863	1900	1863	1863	1900	1845	1845	1900	1863	1863	1863
Adj Flow Rate, veh/h	235	27	38	18	95	4	119	514	4	4	280	280
Adj No. of Lanes	1	2	0	1	2	0	1	1	0	1	1	1
Peak Hour Factor	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91
Percent Heavy Veh, %	2	2	2	2	2	2	3	3	3	2	2	2
Cap, veh/h	567	600	537	583	1174	49	405	741	6	305	755	642
Arrive On Green	0.34	0.34	0.34	0.34	0.34	0.34	0.41	0.41	0.41	0.41	0.41	0.41
Sat Flow, veh/h	1291	1770	1583	1331	3462	145	838	1828	14	880	1863	1583
Grp Volume(v), veh/h	235	27	38	18	48	51	119	0	518	4	280	280
Grp Sat Flow(s),veh/h/ln	1291	1770	1583	1331	1770	1837	838	0	1842	880	1863	1583
Q Serve(g_s), s	7.1	0.5	0.8	0.4	0.9	0.9	5.4	0.0	10.9	0.2	4.9	6.0
Cycle Q Clear(g_c), s	8.0	0.5	0.8	1.2	0.9	0.9	10.4	0.0	10.9	11.1	4.9	6.0
Prop In Lane	1.00		1.00	1.00		0.08	1.00		0.01	1.00		1.00
Lane Grp Cap(c), veh/h	567	600	537	583	600	623	405	0	747	305	755	642
V/C Ratio(X)	0.41	0.04	0.07	0.03	0.08	0.08	0.29	0.00	0.69	0.01	0.37	0.44
Avail Cap(c_a), veh/h	651	716	640	670	716	743	582	0	1137	492	1150	977
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.00	1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	13.3	10.4	10.5	10.9	10.5	10.6	13.4	0.0	11.6	16.1	9.8	10.1
Incr Delay (d2), s/veh	0.5	0.0	0.1	0.0	0.1	0.1	0.4	0.0	1.2	0.0	0.3	0.5
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	2.6	0.2	0.3	0.2	0.4	0.4	1.3	0.0	5.7	0.0	2.6	2.7
LnGrp Delay(d),s/veh	13.7	10.4	10.6	10.9	10.6	10.6	13.8	0.0	12.7	16.2	10.1	10.6
LnGrp LOS	B	B	B	B	B	B	B		B	B	B	B
Approach Vol, veh/h		300			117			637			564	
Approach Delay, s/veh		13.0			10.7			12.9			10.4	
Approach LOS		B			B			B			B	

Timer	1	2	3	4	5	6	7	8
Assigned Phs		2		4		6		8
Phs Duration (G+Y+Rc), s		25.0		21.9		25.0		21.9
Change Period (Y+Rc), s		6.0		6.0		6.0		6.0
Max Green Setting (Gmax), s		29.0		19.0		29.0		19.0
Max Q Clear Time (g_c+I1), s		13.1		3.2		12.9		10.0
Green Ext Time (p_c), s		5.9		1.5		6.0		1.2

Intersection Summary	
HCM 2010 Ctrl Delay	11.9
HCM 2010 LOS	B

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	18	20	51	4	13	5	43	236	6	5	435	45
Number	3	8	18	7	4	14	1	6	16	5	2	12
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1900	1759	1900	1810	1810	1900	1776	1776	1900	1792	1792	1900
Adj Flow Rate, veh/h	20	23	58	5	15	6	49	268	7	6	494	51
Adj No. of Lanes	0	1	0	1	1	0	1	1	0	1	1	0
Peak Hour Factor	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88
Percent Heavy Veh, %	8	8	8	5	5	5	7	7	7	6	6	6
Cap, veh/h	141	144	253	546	350	140	324	768	20	525	712	74
Arrive On Green	0.28	0.28	0.28	0.28	0.28	0.28	0.45	0.45	0.45	0.45	0.45	0.45
Sat Flow, veh/h	155	505	890	1275	1230	492	818	1723	45	1058	1598	165
Grp Volume(v), veh/h	101	0	0	5	0	21	49	0	275	6	0	545
Grp Sat Flow(s),veh/h/ln	1549	0	0	1275	0	1723	818	0	1768	1058	0	1763
Q Serve(g_s), s	0.0	0.0	0.0	0.0	0.0	0.4	2.3	0.0	4.5	0.2	0.0	11.0
Cycle Q Clear(g_c), s	2.1	0.0	0.0	0.1	0.0	0.4	13.3	0.0	4.5	4.7	0.0	11.0
Prop In Lane	0.20		0.57	1.00		0.29	1.00		0.03	1.00		0.09
Lane Grp Cap(c), veh/h	538	0	0	546	0	490	324	0	788	525	0	786
V/C Ratio(X)	0.19	0.00	0.00	0.01	0.00	0.04	0.15	0.00	0.35	0.01	0.00	0.69
Avail Cap(c_a), veh/h	752	0	0	727	0	735	492	0	1152	743	0	1149
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	0.00	0.00	1.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00	1.00
Uniform Delay (d), s/veh	12.2	0.0	0.0	11.4	0.0	11.5	15.2	0.0	8.1	9.6	0.0	9.9
Incr Delay (d2), s/veh	0.2	0.0	0.0	0.0	0.0	0.0	0.2	0.0	0.3	0.0	0.0	1.1
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	1.0	0.0	0.0	0.0	0.0	0.2	0.5	0.0	2.3	0.0	0.0	5.5
LnGrp Delay(d),s/veh	12.3	0.0	0.0	11.4	0.0	11.6	15.5	0.0	8.4	9.7	0.0	11.0
LnGrp LOS	B			B		B	B		A	A		B
Approach Vol, veh/h		101			26			324			551	
Approach Delay, s/veh		12.3			11.5			9.4			11.0	
Approach LOS		B			B			A			B	

Timer	1	2	3	4	5	6	7	8
Assigned Phs		2		4		6		8
Phs Duration (G+Y+Rc), s		25.8		18.7		25.8		18.7
Change Period (Y+Rc), s		6.0		6.0		6.0		6.0
Max Green Setting (Gmax), s		29.0		19.0		29.0		19.0
Max Q Clear Time (g_c+I1), s		13.0		2.4		15.3		4.1
Green Ext Time (p_c), s		4.9		0.6		4.5		0.5

Intersection Summary	
HCM 2010 Ctrl Delay	10.6
HCM 2010 LOS	B

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	22	25	83	5	33	11	122	545	4	10	265	36
Number	3	8	18	7	4	14	1	6	16	5	2	12
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1900	1863	1900	1827	1827	1900	1863	1863	1900	1827	1827	1900
Adj Flow Rate, veh/h	23	26	86	5	34	11	127	568	4	10	276	38
Adj No. of Lanes	0	1	0	1	1	0	1	1	0	1	1	0
Peak Hour Factor	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96
Percent Heavy Veh, %	2	2	2	4	4	4	2	2	2	4	4	4
Cap, veh/h	134	143	326	579	416	135	478	786	6	296	669	92
Arrive On Green	0.31	0.31	0.31	0.31	0.31	0.31	0.43	0.43	0.43	0.43	0.43	0.43
Sat Flow, veh/h	135	456	1038	1251	1323	428	1061	1847	13	821	1572	216
Grp Volume(v), veh/h	135	0	0	5	0	45	127	0	572	10	0	314
Grp Sat Flow(s),veh/h/ln	1629	0	0	1251	0	1751	1061	0	1860	821	0	1789
Q Serve(g_s), s	0.0	0.0	0.0	0.0	0.0	0.8	4.4	0.0	11.8	0.5	0.0	5.6
Cycle Q Clear(g_c), s	2.8	0.0	0.0	0.1	0.0	0.8	10.0	0.0	11.8	12.2	0.0	5.6
Prop In Lane	0.17		0.64	1.00		0.24	1.00		0.01	1.00		0.12
Lane Grp Cap(c), veh/h	603	0	0	579	0	551	478	0	792	296	0	761
V/C Ratio(X)	0.22	0.00	0.00	0.01	0.00	0.08	0.27	0.00	0.72	0.03	0.00	0.41
Avail Cap(c_a), veh/h	758	0	0	701	0	721	693	0	1169	463	0	1124
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	0.00	0.00	1.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00	1.00
Uniform Delay (d), s/veh	11.8	0.0	0.0	10.9	0.0	11.1	12.7	0.0	11.0	16.1	0.0	9.2
Incr Delay (d2), s/veh	0.2	0.0	0.0	0.0	0.0	0.1	0.3	0.0	1.3	0.0	0.0	0.4
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	1.3	0.0	0.0	0.0	0.0	0.4	1.3	0.0	6.2	0.1	0.0	2.9
LnGrp Delay(d),s/veh	12.0	0.0	0.0	10.9	0.0	11.2	13.0	0.0	12.3	16.1	0.0	9.6
LnGrp LOS	B			B		B	B		B	B		A
Approach Vol, veh/h		135			50			699			324	
Approach Delay, s/veh		12.0			11.2			12.4			9.8	
Approach LOS		B			B			B			A	

Timer	1	2	3	4	5	6	7	8
Assigned Phs		2		4		6		8
Phs Duration (G+Y+Rc), s		25.6		20.5		25.6		20.5
Change Period (Y+Rc), s		6.0		6.0		6.0		6.0
Max Green Setting (Gmax), s		29.0		19.0		29.0		19.0
Max Q Clear Time (g_c+I1), s		14.2		2.8		13.8		4.8
Green Ext Time (p_c), s		5.4		0.9		5.5		0.8

Intersection Summary	
HCM 2010 Ctrl Delay	11.6
HCM 2010 LOS	B

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Volume (veh/h)	29	0	258	48	0	478
Number	7	14	6	16	5	2
Initial Q (Qb), veh	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00	1.00		1.00	1.00	
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1727	1727	1776	1776	0	1827
Adj Flow Rate, veh/h	33	0	293	0	0	543
Adj No. of Lanes	1	1	1	1	0	1
Peak Hour Factor	0.88	0.88	0.88	0.88	0.88	0.88
Percent Heavy Veh, %	10	10	7	7	0	4
Cap, veh/h	119	106	942	800	0	969
Arrive On Green	0.07	0.00	0.53	0.00	0.00	0.53
Sat Flow, veh/h	1645	1468	1776	1509	0	1827
Grp Volume(v), veh/h	33	0	293	0	0	543
Grp Sat Flow(s),veh/h/ln	1645	1468	1776	1509	0	1827
Q Serve(g_s), s	0.6	0.0	2.8	0.0	0.0	6.0
Cycle Q Clear(g_c), s	0.6	0.0	2.8	0.0	0.0	6.0
Prop In Lane	1.00	1.00		1.00	0.00	
Lane Grp Cap(c), veh/h	119	106	942	800	0	969
V/C Ratio(X)	0.28	0.00	0.31	0.00	0.00	0.56
Avail Cap(c_a), veh/h	491	438	1412	1200	0	1453
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	0.00	1.00	0.00	0.00	1.00
Uniform Delay (d), s/veh	13.3	0.0	4.0	0.0	0.0	4.7
Incr Delay (d2), s/veh	1.3	0.0	0.2	0.0	0.0	0.5
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	0.3	0.0	1.4	0.0	0.0	3.0
LnGrp Delay(d),s/veh	14.5	0.0	4.2	0.0	0.0	5.2
LnGrp LOS	B		A			A
Approach Vol, veh/h	33		293			543
Approach Delay, s/veh	14.5		4.2			5.2
Approach LOS	B		A			A

Timer	1	2	3	4	5	6	7	8
Assigned Phs		2		4		6		
Phs Duration (G+Y+Rc), s		22.0		8.2		22.0		
Change Period (Y+Rc), s		6.0		6.0		6.0		
Max Green Setting (Gmax), s		24.0		9.0		24.0		
Max Q Clear Time (g_c+I1), s		8.0		2.6		4.8		
Green Ext Time (p_c), s		4.7		0.0		5.1		

Intersection Summary	
HCM 2010 Ctrl Delay	5.2
HCM 2010 LOS	A

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Volume (veh/h)	48	0	591	56	0	366
Number	7	14	6	16	5	2
Initial Q (Qb), veh	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00	1.00		1.00	1.00	
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1759	1759	1827	1827	0	1827
Adj Flow Rate, veh/h	49	0	609	0	0	377
Adj No. of Lanes	1	1	1	1	0	1
Peak Hour Factor	0.97	0.97	0.97	0.97	0.97	0.97
Percent Heavy Veh, %	8	8	4	4	0	4
Cap, veh/h	167	149	940	799	0	940
Arrive On Green	0.10	0.00	0.51	0.00	0.00	0.51
Sat Flow, veh/h	1675	1495	1827	1553	0	1827
Grp Volume(v), veh/h	49	0	609	0	0	377
Grp Sat Flow(s),veh/h/ln	1675	1495	1827	1553	0	1827
Q Serve(g_s), s	0.8	0.0	7.6	0.0	0.0	3.9
Cycle Q Clear(g_c), s	0.8	0.0	7.6	0.0	0.0	3.9
Prop In Lane	1.00	1.00		1.00	0.00	
Lane Grp Cap(c), veh/h	167	149	940	799	0	940
V/C Ratio(X)	0.29	0.00	0.65	0.00	0.00	0.40
Avail Cap(c_a), veh/h	485	433	1410	1198	0	1410
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	0.00	1.00	0.00	0.00	1.00
Uniform Delay (d), s/veh	13.0	0.0	5.5	0.0	0.0	4.6
Incr Delay (d2), s/veh	1.0	0.0	0.8	0.0	0.0	0.3
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	0.4	0.0	3.9	0.0	0.0	2.0
LnGrp Delay(d),s/veh	13.9	0.0	6.3	0.0	0.0	4.9
LnGrp LOS	B		A			A
Approach Vol, veh/h	49		609			377
Approach Delay, s/veh	13.9		6.3			4.9
Approach LOS	B		A			A

Timer	1	2	3	4	5	6	7	8
Assigned Phs		2		4		6		
Phs Duration (G+Y+Rc), s		22.0		9.1		22.0		
Change Period (Y+Rc), s		6.0		6.0		6.0		
Max Green Setting (Gmax), s		24.0		9.0		24.0		
Max Q Clear Time (g_c+I1), s		5.9		2.8		9.6		
Green Ext Time (p_c), s		6.1		0.0		5.4		

Intersection Summary	
HCM 2010 Ctrl Delay	6.1
HCM 2010 LOS	A

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	4	325	17	33	15	21	11	189	361	169	356	7
Number	3	8	18	7	4	14	1	6	16	5	2	12
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1900	1863	1900	1792	1792	1792	1845	1845	1900	1845	1845	1900
Adj Flow Rate, veh/h	4	357	19	36	16	23	12	208	397	186	391	8
Adj No. of Lanes	0	2	0	1	1	1	1	1	0	1	1	0
Peak Hour Factor	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91
Percent Heavy Veh, %	2	2	2	6	6	6	3	3	3	3	3	3
Cap, veh/h	58	814	43	257	437	372	552	326	622	372	1032	21
Arrive On Green	0.24	0.24	0.24	0.24	0.24	0.24	0.57	0.57	0.57	0.57	0.57	0.57
Sat Flow, veh/h	9	3338	176	965	1792	1524	972	568	1085	804	1801	37
Grp Volume(v), veh/h	200	0	180	36	16	23	12	0	605	186	0	399
Grp Sat Flow(s),veh/h/ln	1859	0	1664	965	1792	1524	972	0	1653	804	0	1838
Q Serve(g_s), s	0.0	0.0	6.0	2.2	0.4	0.8	0.4	0.0	16.2	13.3	0.0	7.8
Cycle Q Clear(g_c), s	6.0	0.0	6.0	8.2	0.4	0.8	8.2	0.0	16.2	29.5	0.0	7.8
Prop In Lane	0.02		0.11	1.00		1.00	1.00		0.66	1.00		0.02
Lane Grp Cap(c), veh/h	510	0	406	257	437	372	552	0	947	372	0	1053
V/C Ratio(X)	0.39	0.00	0.44	0.14	0.04	0.06	0.02	0.00	0.64	0.50	0.00	0.38
Avail Cap(c_a), veh/h	510	0	406	257	437	372	647	0	1109	451	0	1233
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	0.00	1.00	1.00	1.00	1.00	1.00	0.00	1.00	1.00	0.00	1.00
Uniform Delay (d), s/veh	21.0	0.0	21.0	24.5	18.9	19.0	9.9	0.0	9.4	19.3	0.0	7.6
Incr Delay (d2), s/veh	0.5	0.0	0.8	0.2	0.0	0.1	0.0	0.0	1.0	1.0	0.0	0.2
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	3.1	0.0	2.8	0.6	0.2	0.3	0.1	0.0	7.5	3.1	0.0	3.9
LnGrp Delay(d),s/veh	21.5	0.0	21.8	24.7	18.9	19.1	9.9	0.0	10.4	20.4	0.0	7.9
LnGrp LOS	C		C	C	B	B	A		B	C		A
Approach Vol, veh/h		380			75			617			585	
Approach Delay, s/veh		21.6			21.8			10.4			11.8	
Approach LOS		C			C			B			B	

Timer	1	2	3	4	5	6	7	8
Assigned Phs		2		4		6		8
Phs Duration (G+Y+Rc), s		43.6		22.0		43.6		22.0
Change Period (Y+Rc), s		6.0		6.0		6.0		6.0
Max Green Setting (Gmax), s		44.0		16.0		44.0		16.0
Max Q Clear Time (g_c+I1), s		31.5		10.2		18.2		8.0
Green Ext Time (p_c), s		6.1		1.3		8.8		1.6

Intersection Summary	
HCM 2010 Ctrl Delay	14.0
HCM 2010 LOS	B

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	21	22	30	287	187	191	15	419	43	23	335	9
Number	3	8	18	7	4	14	1	6	16	5	2	12
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1900	1845	1900	1863	1863	1863	1792	1792	1900	1810	1810	1900
Adj Flow Rate, veh/h	22	23	32	305	199	203	16	446	46	24	356	10
Adj No. of Lanes	0	2	0	1	1	1	1	1	0	1	1	0
Peak Hour Factor	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94
Percent Heavy Veh, %	3	3	3	2	2	2	6	6	6	5	5	5
Cap, veh/h	291	271	415	576	622	529	409	664	68	316	727	20
Arrive On Green	0.33	0.33	0.33	0.33	0.33	0.33	0.42	0.42	0.42	0.42	0.42	0.42
Sat Flow, veh/h	522	812	1242	1343	1863	1583	974	1598	165	875	1752	49
Grp Volume(v), veh/h	39	0	38	305	199	203	16	0	492	24	0	366
Grp Sat Flow(s),veh/h/ln	1116	0	1459	1343	1863	1583	974	0	1763	875	0	1801
Q Serve(g_s), s	0.1	0.0	0.8	9.6	3.8	4.7	0.6	0.0	10.8	1.1	0.0	7.1
Cycle Q Clear(g_c), s	3.9	0.0	0.8	10.5	3.8	4.7	7.7	0.0	10.8	11.9	0.0	7.1
Prop In Lane	0.56		0.85	1.00		1.00	1.00		0.09	1.00		0.03
Lane Grp Cap(c), veh/h	490	0	488	576	622	529	409	0	732	316	0	748
V/C Ratio(X)	0.08	0.00	0.08	0.53	0.32	0.38	0.04	0.00	0.67	0.08	0.00	0.49
Avail Cap(c_a), veh/h	490	0	488	576	622	529	900	0	1620	757	0	1655
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	0.00	1.00	1.00	1.00	1.00	1.00	0.00	1.00	1.00	0.00	1.00
Uniform Delay (d), s/veh	10.9	0.0	10.9	14.5	11.9	12.2	13.1	0.0	11.4	16.2	0.0	10.3
Incr Delay (d2), s/veh	0.1	0.0	0.1	0.9	0.3	0.5	0.0	0.0	1.1	0.1	0.0	0.5
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	0.4	0.0	0.3	3.7	2.0	2.1	0.2	0.0	5.4	0.3	0.0	3.6
LnGrp Delay(d),s/veh	11.0	0.0	11.0	15.4	12.2	12.6	13.1	0.0	12.4	16.3	0.0	10.8
LnGrp LOS	B		B	B	B	B	B		B	B		B
Approach Vol, veh/h		77			707			508			390	
Approach Delay, s/veh		11.0			13.7			12.5			11.1	
Approach LOS		B			B			B			B	

Timer	1	2	3	4	5	6	7	8
Assigned Phs		2		4		6		8
Phs Duration (G+Y+Rc), s		25.9		22.0		25.9		22.0
Change Period (Y+Rc), s		6.0		6.0		6.0		6.0
Max Green Setting (Gmax), s		44.0		16.0		44.0		16.0
Max Q Clear Time (g_c+I1), s		13.9		12.5		12.8		5.9
Green Ext Time (p_c), s		6.0		1.3		6.0		2.6

Intersection Summary	
HCM 2010 Ctrl Delay	12.6
HCM 2010 LOS	B

Intersection	
Int Delay, s/veh	0.2

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Vol, veh/h	4	7	8	528	428	4
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	0	-	250	-	-	-
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	91	91	91	91	91	91
Heavy Vehicles, %	36	36	3	3	7	7
Mvmt Flow	4	8	9	580	470	4

Major/Minor	Minor2		Major1		Major2	
Conflicting Flow All	1071	473	475	0	-	0
Stage 1	473	-	-	-	-	-
Stage 2	598	-	-	-	-	-
Critical Hdwy	6.76	6.56	4.13	-	-	-
Critical Hdwy Stg 1	5.76	-	-	-	-	-
Critical Hdwy Stg 2	5.76	-	-	-	-	-
Follow-up Hdwy	3.824	3.624	2.227	-	-	-
Pot Cap-1 Maneuver	211	527	1082	-	-	-
Stage 1	562	-	-	-	-	-
Stage 2	489	-	-	-	-	-
Platoon blocked, %				-	-	-
Mov Cap-1 Maneuver	209	527	1082	-	-	-
Mov Cap-2 Maneuver	332	-	-	-	-	-
Stage 1	562	-	-	-	-	-
Stage 2	485	-	-	-	-	-

Approach	EB	NB	SB
HCM Control Delay, s	13.5		
HCM LOS	B		

Minor Lane/Major Mvmt	NBL	NBT	EBLn1	SBT	SBR
Capacity (veh/h)	1082	-	434	-	-
HCM Lane V/C Ratio	0.008	-	0.028	-	-
HCM Control Delay (s)	8.4	-	13.5	-	-
HCM Lane LOS	A	-	B	-	-
HCM 95th %tile Q(veh)	0	-	0	-	-

Intersection	
Int Delay, s/veh	0.2

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Vol, veh/h	12	7	4	519	629	6
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	0	-	250	-	-	-
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	99	99	99	99	99	99
Heavy Vehicles, %	26	26	5	5	2	2
Mvmt Flow	12	7	4	524	635	6

Major/Minor	Minor2		Major1		Major2	
Conflicting Flow All	1170	638	641	0	-	0
Stage 1	638	-	-	-	-	-
Stage 2	532	-	-	-	-	-
Critical Hdwy	6.66	6.46	4.15	-	-	-
Critical Hdwy Stg 1	5.66	-	-	-	-	-
Critical Hdwy Stg 2	5.66	-	-	-	-	-
Follow-up Hdwy	3.734	3.534	2.245	-	-	-
Pot Cap-1 Maneuver	191	436	929	-	-	-
Stage 1	483	-	-	-	-	-
Stage 2	544	-	-	-	-	-
Platoon blocked, %				-	-	-
Mov Cap-1 Maneuver	190	436	929	-	-	-
Mov Cap-2 Maneuver	483	-	-	-	-	-
Stage 1	483	-	-	-	-	-
Stage 2	542	-	-	-	-	-

Approach	EB	NB	SB
HCM Control Delay, s	13.1		
HCM LOS	B		

Minor Lane/Major Mvmt	NBL	NBT	EBLn1	SBT	SBR
Capacity (veh/h)	929	-	465	-	-
HCM Lane V/C Ratio	0.004	-	0.041	-	-
HCM Control Delay (s)	8.9	-	13.1	-	-
HCM Lane LOS	A	-	B	-	-
HCM 95th %tile Q(veh)	0	-	0	-	-

Intersection	
Int Delay, s/veh	2.4

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Vol, veh/h	104	378	153	4	7	74
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	-	-	-	-	0	-
Veh in Median Storage, #	-	0	0	-	0	-
Grade, %	-	0	0	-	0	-
Peak Hour Factor	85	85	85	85	85	85
Heavy Vehicles, %	2	2	8	8	4	4
Mvmt Flow	122	445	180	5	8	87

Major/Minor	Major1		Major2		Minor2	
Conflicting Flow All	185	0	-	0	649	92
Stage 1	-	-	-	-	182	-
Stage 2	-	-	-	-	467	-
Critical Hdwy	4.14	-	-	-	6.88	6.98
Critical Hdwy Stg 1	-	-	-	-	5.88	-
Critical Hdwy Stg 2	-	-	-	-	5.88	-
Follow-up Hdwy	2.22	-	-	-	3.54	3.34
Pot Cap-1 Maneuver	1387	-	-	-	398	941
Stage 1	-	-	-	-	825	-
Stage 2	-	-	-	-	591	-
Platoon blocked, %		-	-	-		
Mov Cap-1 Maneuver	1387	-	-	-	351	941
Mov Cap-2 Maneuver	-	-	-	-	351	-
Stage 1	-	-	-	-	825	-
Stage 2	-	-	-	-	522	-

Approach	EB	WB	SB
HCM Control Delay, s	1.9		10
HCM LOS			B

Minor Lane/Major Mvmt	EBL	EBT	WBT	WBR	SBLn1
Capacity (veh/h)	1387	-	-	-	822
HCM Lane V/C Ratio	0.088	-	-	-	0.116
HCM Control Delay (s)	7.8	0.3	-	-	10
HCM Lane LOS	A	A	-	-	B
HCM 95th %tile Q(veh)	0	-	-	-	0

Intersection	
Int Delay, s/veh	2.2

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Vol, veh/h	67	160	466	14	4	95
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	-	-	-	-	0	-
Veh in Median Storage, #	-	0	0	-	0	-
Grade, %	-	0	0	-	0	-
Peak Hour Factor	83	83	83	83	83	83
Heavy Vehicles, %	6	6	3	3	2	2
Mvmt Flow	81	193	561	17	5	114

Major/Minor	Major1		Major2		Minor2	
Conflicting Flow All	578	0	-	0	828	289
Stage 1	-	-	-	-	570	-
Stage 2	-	-	-	-	258	-
Critical Hdwy	4.22	-	-	-	6.84	6.94
Critical Hdwy Stg 1	-	-	-	-	5.84	-
Critical Hdwy Stg 2	-	-	-	-	5.84	-
Follow-up Hdwy	2.26	-	-	-	3.52	3.32
Pot Cap-1 Maneuver	965	-	-	-	309	708
Stage 1	-	-	-	-	529	-
Stage 2	-	-	-	-	761	-
Platoon blocked, %		-	-	-		
Mov Cap-1 Maneuver	965	-	-	-	280	708
Mov Cap-2 Maneuver	-	-	-	-	280	-
Stage 1	-	-	-	-	529	-
Stage 2	-	-	-	-	689	-

Approach	EB	WB	SB
HCM Control Delay, s	2.8		11.6
HCM LOS			B

Minor Lane/Major Mvmt	EBL	EBT	WBT	WBR	SBLn1
Capacity (veh/h)	965	-	-	-	667
HCM Lane V/C Ratio	0.084	-	-	-	0.179
HCM Control Delay (s)	9.1	0.2	-	-	11.6
HCM Lane LOS	A	A	-	-	B
HCM 95th %tile Q(veh)	0	-	-	-	1

Intersection	
Int Delay, s/veh	3.1

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR
Vol, veh/h	323	141	4	4	48	4	4	4	4
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Free	Free	Stop	Stop	Stop
RT Channelized	-	-	None	-	-	None	-	-	None
Storage Length	-	-	-	-	-	-	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-
Peak Hour Factor	76	76	76	76	76	76	76	76	76
Heavy Vehicles, %	2	2	2	22	22	22	2	2	2
Mvmt Flow	425	186	5	5	63	5	5	5	5

Major/Minor	Major1			Major2			Minor1		
Conflicting Flow All	68	0	0	191	0	0	1083	1117	95
Stage 1	-	-	-	-	-	-	1038	1038	-
Stage 2	-	-	-	-	-	-	45	79	-
Critical Hdwy	4.14	-	-	4.54	-	-	7.54	6.54	6.94
Critical Hdwy Stg 1	-	-	-	-	-	-	6.54	5.54	-
Critical Hdwy Stg 2	-	-	-	-	-	-	6.54	5.54	-
Follow-up Hdwy	2.22	-	-	2.42	-	-	3.52	4.02	3.32
Pot Cap-1 Maneuver	1531	-	-	1246	-	-	172	206	943
Stage 1	-	-	-	-	-	-	247	306	-
Stage 2	-	-	-	-	-	-	963	829	-
Platoon blocked, %		-	-		-	-			
Mov Cap-1 Maneuver	1531	-	-	1246	-	-	100	141	943
Mov Cap-2 Maneuver	-	-	-	-	-	-	100	141	-
Stage 1	-	-	-	-	-	-	170	211	-
Stage 2	-	-	-	-	-	-	755	826	-

Approach	EB	WB	NB
HCM Control Delay, s			29.1
HCM LOS			D

Minor Lane/Major Mvmt	NBLn1	EBL	EBT	EBR	WBL	WBT	WBR	SBLn1	SBLn2
Capacity (veh/h)	165	1531	-	-	1246	-	-	139	1028
HCM Lane V/C Ratio	0.096	0.278	-	-	0.004	-	-	0.085	0.207
HCM Control Delay (s)	29.1	8.3	0.2	-	7.9	0	-	33.3	9.4
HCM Lane LOS	D	A	A	-	A	A	-	D	A
HCM 95th %tile Q(veh)	0	1	-	-	0	-	-	0	1

Intersection			
Int Delay, s/veh			

Movement	SBL	SBT	SBR
Vol, veh/h	5	4	162
Conflicting Peds, #/hr	0	0	0
Sign Control	Stop	Stop	Stop
RT Channelized	-	-	None
Storage Length	-	-	0
Veh in Median Storage, #	-	0	-
Grade, %	-	0	-
Peak Hour Factor	76	76	76
Heavy Vehicles, %	3	3	3
Mvmt Flow	7	5	213

Major/Minor	Minor2		
Conflicting Flow All	1021	1117	34
Stage 1	76	76	-
Stage 2	945	1041	-
Critical Hdwy	7.56	6.56	6.96
Critical Hdwy Stg 1	6.56	5.56	-
Critical Hdwy Stg 2	6.56	5.56	-
Follow-up Hdwy	3.53	4.03	3.33
Pot Cap-1 Maneuver	189	204	1028
Stage 1	921	829	-
Stage 2	280	303	-
Platoon blocked, %			
Mov Cap-1 Maneuver	138	140	1028
Mov Cap-2 Maneuver	138	140	-
Stage 1	635	826	-
Stage 2	187	209	-

Approach	SB
HCM Control Delay, s	10.7
HCM LOS	B

Minor Lane/Major Mvmt

Intersection	
Int Delay, s/veh	5.5

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR
Vol, veh/h	123	96	4	4	270	9	4	4	4
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Free	Free	Stop	Stop	Stop
RT Channelized	-	-	None	-	-	None	-	-	None
Storage Length	-	-	-	-	-	-	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-
Peak Hour Factor	72	72	72	72	72	72	72	72	72
Heavy Vehicles, %	7	7	7	3	3	3	2	2	2
Mvmt Flow	171	133	6	6	375	12	6	6	6

Major/Minor	Major1			Major2			Minor1		
Conflicting Flow All	388	0	0	139	0	0	679	877	69
Stage 1	-	-	-	-	-	-	478	478	-
Stage 2	-	-	-	-	-	-	201	399	-
Critical Hdwy	4.24	-	-	4.16	-	-	7.54	6.54	6.94
Critical Hdwy Stg 1	-	-	-	-	-	-	6.54	5.54	-
Critical Hdwy Stg 2	-	-	-	-	-	-	6.54	5.54	-
Follow-up Hdwy	2.27	-	-	2.23	-	-	3.52	4.02	3.32
Pot Cap-1 Maneuver	1132	-	-	1435	-	-	338	285	980
Stage 1	-	-	-	-	-	-	537	554	-
Stage 2	-	-	-	-	-	-	782	601	-
Platoon blocked, %		-	-		-	-			
Mov Cap-1 Maneuver	1132	-	-	1435	-	-	146	237	980
Mov Cap-2 Maneuver	-	-	-	-	-	-	146	237	-
Stage 1	-	-	-	-	-	-	449	463	-
Stage 2	-	-	-	-	-	-	390	598	-

Approach	EB	WB	NB
HCM Control Delay, s			20.6
HCM LOS			C

Minor Lane/Major Mvmt	NBLn1	EBL	EBT	EBR	WBL	WBT	WBR	SBLn1	SBLn2
Capacity (veh/h)	248	1132	-	-	1435	-	-	232	809
HCM Lane V/C Ratio	0.067	0.151	-	-	0.004	-	-	0.096	0.494
HCM Control Delay (s)	20.6	8.7	0.2	-	7.5	0	-	22.2	13.7
HCM Lane LOS	C	A	A	-	A	A	-	C	B
HCM 95th %tile Q(veh)	0	1	-	-	0	-	-	0	3

Intersection			
Int Delay, s/veh			

Movement	SBL	SBT	SBR
Vol, veh/h	12	4	288
Conflicting Peds, #/hr	0	0	0
Sign Control	Stop	Stop	Stop
RT Channelized	-	-	None
Storage Length	-	-	0
Veh in Median Storage, #	-	0	-
Grade, %	-	0	-
Peak Hour Factor	72	72	72
Heavy Vehicles, %	4	4	4
Mvmt Flow	17	6	400

Major/Minor	Minor2		
Conflicting Flow All	803	873	194
Stage 1	392	392	-
Stage 2	411	481	-
Critical Hdwy	7.58	6.58	6.98
Critical Hdwy Stg 1	6.58	5.58	-
Critical Hdwy Stg 2	6.58	5.58	-
Follow-up Hdwy	3.54	4.04	3.34
Pot Cap-1 Maneuver	271	283	809
Stage 1	599	600	-
Stage 2	583	547	-
Platoon blocked, %			
Mov Cap-1 Maneuver	231	235	809
Mov Cap-2 Maneuver	231	235	-
Stage 1	501	597	-
Stage 2	479	457	-

Approach	SB
HCM Control Delay, s	14.1
HCM LOS	B

Minor Lane/Major Mvmt

Intersection	
Int Delay, s/veh	4.3

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR
Vol, veh/h	19	4	127	4	4	4	40	17	4
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0
Sign Control	Stop	Stop	Stop	Stop	Stop	Stop	Free	Free	Free
RT Channelized	-	-	None	-	-	None	-	-	None
Storage Length	-	-	0	-	-	-	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-
Peak Hour Factor	76	76	76	76	76	76	76	76	76
Heavy Vehicles, %	2	2	2	2	2	2	3	3	3
Mvmt Flow	25	5	167	5	5	5	53	22	5

Major/Minor	Minor2			Minor1			Major1		
Conflicting Flow All	312	326	95	231	331	14	191	0	0
Stage 1	193	193	-	130	130	-	-	-	-
Stage 2	119	133	-	101	201	-	-	-	-
Critical Hdwy	7.54	6.54	6.94	7.54	6.54	6.94	4.16	-	-
Critical Hdwy Stg 1	6.54	5.54	-	6.54	5.54	-	-	-	-
Critical Hdwy Stg 2	6.54	5.54	-	6.54	5.54	-	-	-	-
Follow-up Hdwy	3.52	4.02	3.32	3.52	4.02	3.32	2.23	-	-
Pot Cap-1 Maneuver	617	591	943	704	587	1062	1373	-	-
Stage 1	790	740	-	860	788	-	-	-	-
Stage 2	873	785	-	894	734	-	-	-	-
Platoon blocked, %								-	-
Mov Cap-1 Maneuver	590	566	943	556	562	1062	1373	-	-
Mov Cap-2 Maneuver	590	566	-	556	562	-	-	-	-
Stage 1	759	737	-	826	757	-	-	-	-
Stage 2	829	754	-	727	731	-	-	-	-

Approach	EB	WB	NB
HCM Control Delay, s	9.9	10.6	
HCM LOS	A	B	

Minor Lane/Major Mvmt	NBL	NBT	NBR	EBLn1	EBLn2	WBLn1	SBL	SBT	SBR
Capacity (veh/h)	1373	-	-	586	943	664	1584	-	-
HCM Lane V/C Ratio	0.038	-	-	0.052	0.177	0.024	0.003	-	-
HCM Control Delay (s)	7.7	0	-	11.5	9.6	10.6	7.3	0	-
HCM Lane LOS	A	A	-	B	A	B	A	A	-
HCM 95th %tile Q(veh)	0	-	-	0	1	0	0	-	-

Intersection			
Int Delay, s/veh			

Movement	SBL	SBT	SBR
Vol, veh/h	4	133	12
Conflicting Peds, #/hr	0	0	0
Sign Control	Free	Free	Free
RT Channelized	-	-	None
Storage Length	-	-	-
Veh in Median Storage, #	-	0	-
Grade, %	-	0	-
Peak Hour Factor	76	76	76
Heavy Vehicles, %	2	2	2
Mvmt Flow	5	175	16

Major/Minor	Major2		
Conflicting Flow All	28	0	0
Stage 1	-	-	-
Stage 2	-	-	-
Critical Hdwy	4.14	-	-
Critical Hdwy Stg 1	-	-	-
Critical Hdwy Stg 2	-	-	-
Follow-up Hdwy	2.22	-	-
Pot Cap-1 Maneuver	1584	-	-
Stage 1	-	-	-
Stage 2	-	-	-
Platoon blocked, %		-	-
Mov Cap-1 Maneuver	1584	-	-
Mov Cap-2 Maneuver	-	-	-
Stage 1	-	-	-
Stage 2	-	-	-

Approach	SB
HCM Control Delay, s	
HCM LOS	

Minor Lane/Major Mvmt

Intersection	
Int Delay, s/veh	3.2

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR
Vol, veh/h	19	4	89	4	4	4	222	117	4
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0
Sign Control	Stop	Stop	Stop	Stop	Stop	Stop	Free	Free	Free
RT Channelized	-	-	None	-	-	None	-	-	None
Storage Length	-	-	0	-	-	-	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-
Peak Hour Factor	65	65	65	65	65	65	65	65	65
Heavy Vehicles, %	7	7	7	2	2	2	3	3	3
Mvmt Flow	29	6	137	6	6	6	342	180	6

Major/Minor	Minor2			Minor1			Major1		
Conflicting Flow All	875	968	65	903	1009	93	131	0	0
Stage 1	99	99	-	866	866	-	-	-	-
Stage 2	776	869	-	37	143	-	-	-	-
Critical Hdwy	7.64	6.64	7.04	7.54	6.54	6.94	4.16	-	-
Critical Hdwy Stg 1	6.64	5.64	-	6.54	5.54	-	-	-	-
Critical Hdwy Stg 2	6.64	5.64	-	6.54	5.54	-	-	-	-
Follow-up Hdwy	3.57	4.07	3.37	3.52	4.02	3.32	2.23	-	-
Pot Cap-1 Maneuver	236	244	970	232	239	946	1445	-	-
Stage 1	882	801	-	314	369	-	-	-	-
Stage 2	346	356	-	974	778	-	-	-	-
Platoon blocked, %								-	-
Mov Cap-1 Maneuver	181	179	970	154	175	946	1445	-	-
Mov Cap-2 Maneuver	181	179	-	154	175	-	-	-	-
Stage 1	649	797	-	231	272	-	-	-	-
Stage 2	247	262	-	826	774	-	-	-	-

Approach	EB	WB	NB
HCM Control Delay, s	13.5	22.3	
HCM LOS	B	C	

Minor Lane/Major Mvmt	NBL	NBT	NBR	EBLn1	EBLn2	WBLn1	SBL	SBT	SBR
Capacity (veh/h)	1445	-	-	181	970	226	1357	-	-
HCM Lane V/C Ratio	0.236	-	-	0.195	0.141	0.082	0.005	-	-
HCM Control Delay (s)	8.3	0.2	-	29.7	9.3	22.3	7.7	0	-
HCM Lane LOS	A	A	-	D	A	C	A	A	-
HCM 95th %tile Q(veh)	1	-	-	1	0	0	0	-	-

Intersection	
Int Delay, s/veh	

Movement	SBL	SBT	SBR
Vol, veh/h	4	28	57
Conflicting Peds, #/hr	0	0	0
Sign Control	Free	Free	Free
RT Channelized	-	-	None
Storage Length	-	-	-
Veh in Median Storage, #	-	0	-
Grade, %	-	0	-
Peak Hour Factor	65	65	65
Heavy Vehicles, %	6	6	6
Mvmt Flow	6	43	88

Major/Minor	Major2		
Conflicting Flow All	186	0	0
Stage 1	-	-	-
Stage 2	-	-	-
Critical Hdwy	4.22	-	-
Critical Hdwy Stg 1	-	-	-
Critical Hdwy Stg 2	-	-	-
Follow-up Hdwy	2.26	-	-
Pot Cap-1 Maneuver	1357	-	-
Stage 1	-	-	-
Stage 2	-	-	-
Platoon blocked, %		-	-
Mov Cap-1 Maneuver	1357	-	-
Mov Cap-2 Maneuver	-	-	-
Stage 1	-	-	-
Stage 2	-	-	-

Approach	SB
HCM Control Delay, s	
HCM LOS	

Minor Lane/Major Mvmt

Intersection	
Intersection Delay, s/veh	15.4
Intersection LOS	C

Movement	EBU	EBL	EBT	EBR	WBU	WBL	WBT	WBR	NBU	NBL	NBT	NBR
Vol, veh/h	0	25	5	89	0	6	5	22	0	150	80	4
Peak Hour Factor	0.90	0.80	0.80	0.80	0.90	0.80	0.80	0.80	0.90	0.80	0.80	0.80
Heavy Vehicles, %	2	2	2	2	2	6	6	6	2	3	3	3
Mvmt Flow	0	31	6	111	0	7	6	27	0	187	100	5
Number of Lanes	0	0	1	0	0	0	1	1	0	0	1	1

Approach	EB	WB	NB
Opposing Approach	WB	EB	SB
Opposing Lanes	2	1	1
Conflicting Approach Left	SB	NB	EB
Conflicting Lanes Left	1	2	1
Conflicting Approach Right	NB	SB	WB
Conflicting Lanes Right	2	1	2
HCM Control Delay	11.4	9.6	14
HCM LOS	B	A	B

Lane	NBLn1	NBLn2	EBLn1	WBLn1	WBLn2	SBLn1
Vol Left, %	65%	0%	21%	55%	0%	26%
Vol Thru, %	35%	0%	4%	45%	0%	51%
Vol Right, %	0%	100%	75%	0%	100%	23%
Sign Control	Stop	Stop	Stop	Stop	Stop	Stop
Traffic Vol by Lane	230	4	119	11	22	339
LT Vol	80	0	5	5	0	173
Through Vol	0	4	89	0	22	78
RT Vol	150	0	25	6	0	88
Lane Flow Rate	288	5	149	14	28	424
Geometry Grp	7	7	6	7	7	6
Degree of Util (X)	0.479	0.007	0.257	0.028	0.047	0.651
Departure Headway (Hd)	5.997	4.959	6.212	7.204	6.211	5.534
Convergence, Y/N	Yes	Yes	Yes	Yes	Yes	Yes
Cap	601	721	579	496	575	653
Service Time	3.729	2.69	4.253	4.955	3.962	3.563
HCM Lane V/C Ratio	0.479	0.007	0.257	0.028	0.049	0.649
HCM Control Delay	14.1	7.7	11.4	10.2	9.3	18.3
HCM Lane LOS	B	A	B	B	A	C
HCM 95th-tile Q	2.6	0	1	0.1	0.1	4.8

Intersection	
Intersection Delay, s/veh	
Intersection LOS	

Movement	SBU	SBL	SBT	SBR
Vol, veh/h	0	88	173	78
Peak Hour Factor	0.90	0.80	0.80	0.80
Heavy Vehicles, %	2	2	2	2
Mvmt Flow	0	110	216	97
Number of Lanes	0	0	1	0

Approach	SB
Opposing Approach	NB
Opposing Lanes	2
Conflicting Approach Left	WB
Conflicting Lanes Left	2
Conflicting Approach Right	EB
Conflicting Lanes Right	1
HCM Control Delay	18.3
HCM LOS	C

Lane

Intersection	
Intersection Delay, s/veh	12.9
Intersection LOS	B

Movement	EBU	EBL	EBT	EBR	WBU	WBL	WBT	WBR	NBU	NBL	NBT	NBR
Vol, veh/h	0	48	4	69	0	4	4	148	0	55	159	5
Peak Hour Factor	0.90	0.77	0.77	0.77	0.90	0.77	0.77	0.77	0.90	0.77	0.77	0.77
Heavy Vehicles, %	2	2	2	2	2	3	3	3	2	4	4	4
Mvmt Flow	0	62	5	90	0	5	5	192	0	71	206	6
Number of Lanes	0	0	1	0	0	0	1	1	0	0	1	1

Approach	EB	WB	NB
Opposing Approach	WB	EB	SB
Opposing Lanes	2	1	1
Conflicting Approach Left	SB	NB	EB
Conflicting Lanes Left	1	2	1
Conflicting Approach Right	NB	SB	WB
Conflicting Lanes Right	2	1	2
HCM Control Delay	11.8	11	14.3
HCM LOS	B	B	B

Lane	NBLn1	NBLn2	EBLn1	WBLn1	WBLn2	SBLn1
Vol Left, %	26%	0%	40%	50%	0%	15%
Vol Thru, %	74%	0%	3%	50%	0%	69%
Vol Right, %	0%	100%	57%	0%	100%	16%
Sign Control	Stop	Stop	Stop	Stop	Stop	Stop
Traffic Vol by Lane	214	5	121	8	148	189
LT Vol	159	0	4	4	0	130
Through Vol	0	5	69	0	148	31
RT Vol	55	0	48	4	0	28
Lane Flow Rate	278	6	157	10	192	245
Geometry Grp	7	7	6	7	7	6
Degree of Util (X)	0.476	0.01	0.275	0.019	0.307	0.421
Departure Headway (Hd)	6.171	5.331	6.291	6.71	5.744	6.172
Convergence, Y/N	Yes	Yes	Yes	Yes	Yes	Yes
Cap	584	669	569	532	623	582
Service Time	3.924	3.084	4.36	4.475	3.509	4.229
HCM Lane V/C Ratio	0.476	0.009	0.276	0.019	0.308	0.421
HCM Control Delay	14.4	8.1	11.8	9.6	11.1	13.7
HCM Lane LOS	B	A	B	A	B	B
HCM 95th-tile Q	2.6	0	1.1	0.1	1.3	2.1

Intersection	
Intersection Delay, s/veh	
Intersection LOS	

Movement	SBU	SBL	SBT	SBR
Vol, veh/h	0	28	130	31
Peak Hour Factor	0.90	0.77	0.77	0.77
Heavy Vehicles, %	2	7	7	7
Mvmt Flow	0	36	169	40
Number of Lanes	0	0	1	0

Approach	SB
Opposing Approach	NB
Opposing Lanes	2
Conflicting Approach Left	WB
Conflicting Lanes Left	2
Conflicting Approach Right	EB
Conflicting Lanes Right	1
HCM Control Delay	13.7
HCM LOS	B

Lane

Intersection	
Int Delay, s/veh	1.1

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Vol, veh/h	4	18	145	4	52	353
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	0	-	-	-	-	-
Veh in Median Storage, #	0	-	0	-	-	0
Grade, %	0	-	0	-	-	0
Peak Hour Factor	87	87	87	87	87	87
Heavy Vehicles, %	26	26	5	5	3	3
Mvmt Flow	5	21	167	5	60	406

Major/Minor	Minor1		Major1		Major2	
Conflicting Flow All	694	169	0	0	171	0
Stage 1	169	-	-	-	-	-
Stage 2	525	-	-	-	-	-
Critical Hdwy	6.66	6.46	-	-	4.13	-
Critical Hdwy Stg 1	5.66	-	-	-	-	-
Critical Hdwy Stg 2	5.66	-	-	-	-	-
Follow-up Hdwy	3.734	3.534	-	-	2.227	-
Pot Cap-1 Maneuver	375	816	-	-	1400	-
Stage 1	806	-	-	-	-	-
Stage 2	548	-	-	-	-	-
Platoon blocked, %			-	-		-
Mov Cap-1 Maneuver	354	816	-	-	1400	-
Mov Cap-2 Maneuver	354	-	-	-	-	-
Stage 1	806	-	-	-	-	-
Stage 2	518	-	-	-	-	-

Approach	WB	NB	SB
HCM Control Delay, s	10.7		1
HCM LOS	B		

Minor Lane/Major Mvmt	NBT	NBR	WBLn1	SBL	SBT
Capacity (veh/h)	-	-	660	1400	-
HCM Lane V/C Ratio	-	-	0.038	0.043	-
HCM Control Delay (s)	-	-	10.7	7.7	0
HCM Lane LOS	-	-	B	A	A
HCM 95th %tile Q(veh)	-	-	0	0	-

Intersection	
Int Delay, s/veh	2.1

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Vol, veh/h	5	73	370	4	12	111
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	0	-	-	-	-	-
Veh in Median Storage, #	0	-	0	-	-	0
Grade, %	0	-	0	-	-	0
Peak Hour Factor	65	65	65	65	65	65
Heavy Vehicles, %	10	10	3	3	18	18
Mvmt Flow	8	112	569	6	18	171

Major/Minor	Minor1		Major1		Major2	
Conflicting Flow All	780	572	0	0	575	0
Stage 1	572	-	-	-	-	-
Stage 2	208	-	-	-	-	-
Critical Hdwy	6.5	6.3	-	-	4.28	-
Critical Hdwy Stg 1	5.5	-	-	-	-	-
Critical Hdwy Stg 2	5.5	-	-	-	-	-
Follow-up Hdwy	3.59	3.39	-	-	2.362	-
Pot Cap-1 Maneuver	353	505	-	-	924	-
Stage 1	549	-	-	-	-	-
Stage 2	808	-	-	-	-	-
Platoon blocked, %			-	-		-
Mov Cap-1 Maneuver	345	505	-	-	924	-
Mov Cap-2 Maneuver	549	-	-	-	-	-
Stage 1	549	-	-	-	-	-
Stage 2	790	-	-	-	-	-

Approach	WB	NB	SB
HCM Control Delay, s	14.3		0.9
HCM LOS	B		

Minor Lane/Major Mvmt	NBT	NBR	WBLn1	SBL	SBT
Capacity (veh/h)	-	-	508	924	-
HCM Lane V/C Ratio	-	-	0.236	0.02	-
HCM Control Delay (s)	-	-	14.3	9	0
HCM Lane LOS	-	-	B	A	A
HCM 95th %tile Q(veh)	-	-	1	0	-

Intersection	
Int Delay, s/veh	0.5

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Vol, veh/h	12	131	100	94	288	25
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	Free	-	None	-	None
Storage Length	0	100	-	-	0	-
Veh in Median Storage, #	0	-	0	-	-	0
Grade, %	0	-	0	-	-	0
Peak Hour Factor	87	87	87	87	87	87
Heavy Vehicles, %	9	9	2	2	4	4
Mvmt Flow	14	151	115	108	331	29

Major/Minor	Minor1		Major1		Major2	
Conflicting Flow All	860	-	0	0	223	0
Stage 1	169	-	-	-	-	-
Stage 2	691	-	-	-	-	-
Critical Hdwy	6.49	-	-	-	4.14	-
Critical Hdwy Stg 1	5.49	-	-	-	-	-
Critical Hdwy Stg 2	5.49	-	-	-	-	-
Follow-up Hdwy	3.581	-	-	-	2.236	-
Pot Cap-1 Maneuver	317	0	-	-	1334	-
Stage 1	844	0	-	-	-	-
Stage 2	485	0	-	-	-	-
Platoon blocked, %			-	-		-
Mov Cap-1 Maneuver	238	-	-	-	1334	-
Mov Cap-2 Maneuver	238	-	-	-	-	-
Stage 1	844	-	-	-	-	-
Stage 2	365	-	-	-	-	-

Approach	WB	NB	SB
HCM Control Delay, s	21.1		
HCM LOS	C		

Minor Lane/Major Mvmt	NBT	NBR	WBLn1	WBLn2	SBL	SBT
Capacity (veh/h)	-	-	238	-	1334	-
HCM Lane V/C Ratio	-	-	0.058	-	0.248	-
HCM Control Delay (s)	-	-	21.1	0	8.6	-
HCM Lane LOS	-	-	C	A	A	-
HCM 95th %tile Q(veh)	-	-	0	-	1	-

Intersection	
Int Delay, s/veh	2.1

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Vol, veh/h	44	415	24	18	100	101
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	Free	-	None	-	None
Storage Length	0	100	-	-	0	-
Veh in Median Storage, #	0	-	0	-	-	0
Grade, %	0	-	0	-	-	0
Peak Hour Factor	70	70	70	70	70	70
Heavy Vehicles, %	3	3	7	7	13	13
Mvmt Flow	63	593	34	26	143	144

Major/Minor	Minor1		Major1		Major2	
Conflicting Flow All	477	-	0	0	60	0
Stage 1	47	-	-	-	-	-
Stage 2	430	-	-	-	-	-
Critical Hdwy	6.43	-	-	-	4.23	-
Critical Hdwy Stg 1	5.43	-	-	-	-	-
Critical Hdwy Stg 2	5.43	-	-	-	-	-
Follow-up Hdwy	3.527	-	-	-	2.317	-
Pot Cap-1 Maneuver	545	0	-	-	1476	-
Stage 1	973	0	-	-	-	-
Stage 2	654	0	-	-	-	-
Platoon blocked, %			-	-		-
Mov Cap-1 Maneuver	492	-	-	-	1476	-
Mov Cap-2 Maneuver	492	-	-	-	-	-
Stage 1	973	-	-	-	-	-
Stage 2	591	-	-	-	-	-

Approach	WB	NB	SB
HCM Control Delay, s	13.4		
HCM LOS	B		

Minor Lane/Major Mvmt	NBT	NBR	WBLn1	WBLn2	SBL	SBT
Capacity (veh/h)	-	-	492	-	1476	-
HCM Lane V/C Ratio	-	-	0.128	-	0.097	-
HCM Control Delay (s)	-	-	13.4	0	7.7	-
HCM Lane LOS	-	-	B	A	A	-
HCM 95th %tile Q(veh)	-	-	0	-	0	-

Intersection	
Int Delay, s/veh	3.4

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Vol, veh/h	93	67	30	174	260	62
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	0	-	150	-	-	-
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	86	86	86	86	86	86
Heavy Vehicles, %	10	10	6	6	10	10
Mvmt Flow	108	78	35	202	302	72

Major/Minor	Minor2		Major1		Major2	
Conflicting Flow All	509	187	374	0	-	0
Stage 1	338	-	-	-	-	-
Stage 2	171	-	-	-	-	-
Critical Hdwy	7	7.1	4.22	-	-	-
Critical Hdwy Stg 1	6	-	-	-	-	-
Critical Hdwy Stg 2	6	-	-	-	-	-
Follow-up Hdwy	3.6	3.4	2.26	-	-	-
Pot Cap-1 Maneuver	474	799	1153	-	-	-
Stage 1	671	-	-	-	-	-
Stage 2	818	-	-	-	-	-
Platoon blocked, %				-	-	-
Mov Cap-1 Maneuver	460	799	1153	-	-	-
Mov Cap-2 Maneuver	460	-	-	-	-	-
Stage 1	671	-	-	-	-	-
Stage 2	793	-	-	-	-	-

Approach	EB	NB	SB
HCM Control Delay, s	14.6		
HCM LOS	B		

Minor Lane/Major Mvmt	NBL	NBT	EBLn1	SBT	SBR
Capacity (veh/h)	1153	-	559	-	-
HCM Lane V/C Ratio	0.03	-	0.333	-	-
HCM Control Delay (s)	8.2	-	14.6	-	-
HCM Lane LOS	A	-	B	-	-
HCM 95th %tile Q(veh)	0	-	1	-	-

Intersection	
Int Delay, s/veh	7.6

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Vol, veh/h	112	65	127	337	129	84
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	0	-	150	-	-	-
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	73	73	73	73	73	73
Heavy Vehicles, %	11	11	4	4	14	14
Mvmt Flow	153	89	174	462	177	115

Major/Minor	Minor2		Major1		Major2	
Conflicting Flow All	813	146	292	0	-	0
Stage 1	234	-	-	-	-	-
Stage 2	579	-	-	-	-	-
Critical Hdwy	7.02	7.12	4.18	-	-	-
Critical Hdwy Stg 1	6.02	-	-	-	-	-
Critical Hdwy Stg 2	6.02	-	-	-	-	-
Follow-up Hdwy	3.61	3.41	2.24	-	-	-
Pot Cap-1 Maneuver	299	847	1252	-	-	-
Stage 1	757	-	-	-	-	-
Stage 2	499	-	-	-	-	-
Platoon blocked, %				-	-	-
Mov Cap-1 Maneuver	257	847	1252	-	-	-
Mov Cap-2 Maneuver	257	-	-	-	-	-
Stage 1	757	-	-	-	-	-
Stage 2	430	-	-	-	-	-

Approach	EB	NB	SB
HCM Control Delay, s	36.7		
HCM LOS	E		

Minor Lane/Major Mvmt	NBL	NBT	EBLn1	SBT	SBR
Capacity (veh/h)	1252	-	345	-	-
HCM Lane V/C Ratio	0.139	-	0.703	-	-
HCM Control Delay (s)	8.3	-	36.7	-	-
HCM Lane LOS	A	-	E	-	-
HCM 95th %tile Q(veh)	0	-	5	-	-

Intersection	
Int Delay, s/veh	10.1

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Vol, veh/h	384	249	0	199	131	0
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	350	0	-	-	-	-
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	89	89	89	89	89	90
Heavy Vehicles, %	8	8	15	15	2	2
Mvmt Flow	431	280	0	224	147	0

Major/Minor	Minor2		Major1		Major2	
Conflicting Flow All	259	74	147	0	-	0
Stage 1	147	-	-	-	-	-
Stage 2	112	-	-	-	-	-
Critical Hdwy	6.96	7.06	4.4	-	-	-
Critical Hdwy Stg 1	5.96	-	-	-	-	-
Critical Hdwy Stg 2	5.96	-	-	-	-	-
Follow-up Hdwy	3.58	3.38	2.35	-	-	-
Pot Cap-1 Maneuver	691	954	1342	-	-	-
Stage 1	847	-	-	-	-	-
Stage 2	883	-	-	-	-	-
Platoon blocked, %				-	-	-
Mov Cap-1 Maneuver	691	954	1342	-	-	-
Mov Cap-2 Maneuver	691	-	-	-	-	-
Stage 1	847	-	-	-	-	-
Stage 2	883	-	-	-	-	-

Approach	EB	NB	SB
HCM Control Delay, s	15.3		
HCM LOS	C		

Minor Lane/Major Mvmt	NBL	NBT	EBLn1	EBLn2	SBT	SBR
Capacity (veh/h)	1342	-	691	954	-	-
HCM Lane V/C Ratio	-	-	0.624	0.293	-	-
HCM Control Delay (s)	0	-	18.5	10.3	-	-
HCM Lane LOS	A	-	C	B	-	-
HCM 95th %tile Q(veh)	0	-	4	1	-	-

Intersection	
Int Delay, s/veh	3.1

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Vol, veh/h	94	76	0	531	170	0
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	350	0	-	-	-	-
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	76	76	76	76	76	76
Heavy Vehicles, %	45	45	6	6	19	19
Mvmt Flow	124	100	0	699	224	0

Major/Minor	Minor2		Major1		Major2	
Conflicting Flow All	573	112	224	0	-	0
Stage 1	224	-	-	-	-	-
Stage 2	349	-	-	-	-	-
Critical Hdwy	7.7	7.8	4.22	-	-	-
Critical Hdwy Stg 1	6.7	-	-	-	-	-
Critical Hdwy Stg 2	6.7	-	-	-	-	-
Follow-up Hdwy	3.95	3.75	2.26	-	-	-
Pot Cap-1 Maneuver	360	798	1313	-	-	-
Stage 1	678	-	-	-	-	-
Stage 2	573	-	-	-	-	-
Platoon blocked, %				-	-	-
Mov Cap-1 Maneuver	360	798	1313	-	-	-
Mov Cap-2 Maneuver	360	-	-	-	-	-
Stage 1	678	-	-	-	-	-
Stage 2	573	-	-	-	-	-

Approach	EB	NB	SB
HCM Control Delay, s	15.7		
HCM LOS	C		

Minor Lane/Major Mvmt	NBL	NBT	EBLn1	EBLn2	SBT	SBR
Capacity (veh/h)	1313	-	360	798	-	-
HCM Lane V/C Ratio	-	-	0.344	0.125	-	-
HCM Control Delay (s)	0	-	20.1	10.2	-	-
HCM Lane LOS	A	-	C	B	-	-
HCM 95th %tile Q(veh)	0	-	1	0	-	-

Intersection	
Int Delay, s/veh	0

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Vol, veh/h	0	0	68	515	131	48
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	Free
Storage Length	0	-	225	-	-	325
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	90	90	88	88	88	88
Heavy Vehicles, %	2	2	11	11	14	14
Mvmt Flow	0	0	77	585	149	55

Major/Minor	Minor2		Major1		Major2	
Conflicting Flow All	596	74	149	0	-	0
Stage 1	149	-	-	-	-	-
Stage 2	447	-	-	-	-	-
Critical Hdwy	6.84	6.94	4.32	-	-	-
Critical Hdwy Stg 1	5.84	-	-	-	-	-
Critical Hdwy Stg 2	5.84	-	-	-	-	-
Follow-up Hdwy	3.52	3.32	2.31	-	-	-
Pot Cap-1 Maneuver	435	973	1367	-	-	0
Stage 1	863	-	-	-	-	0
Stage 2	611	-	-	-	-	0
Platoon blocked, %				-	-	
Mov Cap-1 Maneuver	410	973	1367	-	-	-
Mov Cap-2 Maneuver	410	-	-	-	-	-
Stage 1	863	-	-	-	-	-
Stage 2	577	-	-	-	-	-

Approach	EB	NB	SB
HCM Control Delay, s	0		
HCM LOS	A		

Minor Lane/Major Mvmt	NBL	NBT	EBLn1	SBT
Capacity (veh/h)	1367	-	-	-
HCM Lane V/C Ratio	0.057	-	-	-
HCM Control Delay (s)	7.8	-	0	-
HCM Lane LOS	A	-	A	-
HCM 95th %tile Q(veh)	0	-	-	-

Intersection	
Int Delay, s/veh	0

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Vol, veh/h	0	0	274	351	170	536
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	Free
Storage Length	0	-	225	-	-	325
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	86	86	86	86	86	86
Heavy Vehicles, %	2	2	14	14	17	17
Mvmt Flow	0	0	319	408	198	623

Major/Minor	Minor2		Major1		Major2	
Conflicting Flow All	1039	99	198	0	-	0
Stage 1	198	-	-	-	-	-
Stage 2	841	-	-	-	-	-
Critical Hdwy	6.84	6.94	4.38	-	-	-
Critical Hdwy Stg 1	5.84	-	-	-	-	-
Critical Hdwy Stg 2	5.84	-	-	-	-	-
Follow-up Hdwy	3.52	3.32	2.34	-	-	-
Pot Cap-1 Maneuver	226	937	1289	-	-	0
Stage 1	816	-	-	-	-	0
Stage 2	383	-	-	-	-	0
Platoon blocked, %				-	-	
Mov Cap-1 Maneuver	170	937	1289	-	-	-
Mov Cap-2 Maneuver	170	-	-	-	-	-
Stage 1	816	-	-	-	-	-
Stage 2	288	-	-	-	-	-

Approach	EB	NB	SB
HCM Control Delay, s	0		
HCM LOS	A		

Minor Lane/Major Mvmt	NBL	NBT	EBLn1	SBT
Capacity (veh/h)	1289	-	-	-
HCM Lane V/C Ratio	0.247	-	-	-
HCM Control Delay (s)	8.7	-	0	-
HCM Lane LOS	A	-	A	-
HCM 95th %tile Q(veh)	1	-	-	-

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Volume (veh/h)	413	42	160	371	614	893
Number	3	18	1	6	2	12
Initial Q (Qb), veh	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00	1.00	1.00			1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1827	1900	1845	1845	1845	1845
Adj Flow Rate, veh/h	481	0	170	395	653	950
Adj No. of Lanes	2	1	1	2	2	1
Peak Hour Factor	0.94	0.94	0.94	0.94	0.94	0.94
Percent Heavy Veh, %	4	0	3	3	3	3
Cap, veh/h	539	250	294	2831	2831	1266
Arrive On Green	0.15	0.00	0.81	0.81	1.00	1.00
Sat Flow, veh/h	3480	1615	312	3597	3597	1568
Grp Volume(v), veh/h	481	0	170	395	653	950
Grp Sat Flow(s),veh/h/ln	1740	1615	312	1752	1752	1568
Q Serve(g_s), s	23.7	0.0	40.0	4.3	0.0	0.0
Cycle Q Clear(g_c), s	23.7	0.0	40.0	4.3	0.0	0.0
Prop In Lane	1.00	1.00	1.00			1.00
Lane Grp Cap(c), veh/h	539	250	294	2831	2831	1266
V/C Ratio(X)	0.89	0.00	0.58	0.14	0.23	0.75
Avail Cap(c_a), veh/h	758	352	294	2831	2831	1266
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.67	1.67
Upstream Filter(I)	1.00	0.00	1.00	1.00	0.67	0.67
Uniform Delay (d), s/veh	72.3	0.0	7.1	3.6	0.0	0.0
Incr Delay (d2), s/veh	9.8	0.0	8.1	0.1	0.1	2.8
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	12.1	0.0	4.1	2.1	0.0	1.0
LnGrp Delay(d),s/veh	82.1	0.0	15.2	3.7	0.1	2.8
LnGrp LOS	F		B	A	A	A
Approach Vol, veh/h	481			565	1603	
Approach Delay, s/veh	82.1			7.2	1.7	
Approach LOS	F			A	A	

Timer	1	2	3	4	5	6	7	8
Assigned Phs		2				6		8
Phs Duration (G+Y+Rc), s		147.0				147.0		33.0
Change Period (Y+Rc), s		6.0				6.0		6.0
Max Green Setting (Gmax), s		130.0				130.0		38.0
Max Q Clear Time (g_c+I1), s		2.0				42.0		25.7
Green Ext Time (p_c), s		33.2				31.1		1.4

Intersection Summary	
HCM 2010 Ctrl Delay	17.5
HCM 2010 LOS	B

Notes

User approved volume balancing among the lanes for turning movement.

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Volume (veh/h)	577	95	160	563	504	571
Number	3	18	1	6	2	12
Initial Q (Qb), veh	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00	1.00	1.00			1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1827	1900	1863	1863	1863	1863
Adj Flow Rate, veh/h	693	0	167	586	525	595
Adj No. of Lanes	2	1	1	2	2	1
Peak Hour Factor	0.96	0.96	0.96	0.96	0.96	0.96
Percent Heavy Veh, %	4	0	2	2	2	2
Cap, veh/h	771	358	384	2813	2813	1259
Arrive On Green	0.22	0.00	0.79	0.79	0.26	0.26
Sat Flow, veh/h	3480	1615	501	3632	3632	1583
Grp Volume(v), veh/h	693	0	167	586	525	595
Grp Sat Flow(s),veh/h/ln	1740	1615	501	1770	1770	1583
Q Serve(g_s), s	32.0	0.0	26.5	6.7	19.0	52.3
Cycle Q Clear(g_c), s	32.0	0.0	45.5	6.7	19.0	52.3
Prop In Lane	1.00	1.00	1.00			1.00
Lane Grp Cap(c), veh/h	771	358	384	2813	2813	1259
V/C Ratio(X)	0.90	0.00	0.43	0.21	0.19	0.47
Avail Cap(c_a), veh/h	1389	645	384	2813	2813	1259
HCM Platoon Ratio	1.00	1.00	1.00	1.00	0.33	0.33
Upstream Filter(I)	1.00	0.00	1.00	1.00	0.79	0.79
Uniform Delay (d), s/veh	62.6	0.0	12.7	4.2	19.5	31.8
Incr Delay (d2), s/veh	4.1	0.0	3.6	0.2	0.1	1.0
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	15.8	0.0	4.0	3.3	9.4	23.4
LnGrp Delay(d),s/veh	66.7	0.0	16.3	4.3	19.6	32.8
LnGrp LOS	E		B	A	B	C
Approach Vol, veh/h	693			753	1120	
Approach Delay, s/veh	66.7			7.0	26.6	
Approach LOS	E			A	C	

Timer	1	2	3	4	5	6	7	8
Assigned Phs		2				6		8
Phs Duration (G+Y+Rc), s		137.4				137.4		42.6
Change Period (Y+Rc), s		6.0				6.0		6.0
Max Green Setting (Gmax), s		102.0				102.0		66.0
Max Q Clear Time (g_c+I1), s		54.3				47.5		34.0
Green Ext Time (p_c), s		17.5				18.2		2.6

Intersection Summary	
HCM 2010 Ctrl Delay	31.7
HCM 2010 LOS	C

Notes

User approved volume balancing among the lanes for turning movement.

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Volume (veh/h)	540	287	96	688	1220	595
Number	3	18	1	6	2	12
Initial Q (Qb), veh	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00	1.00	1.00			1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1810	1900	1827	1827	1827	1827
Adj Flow Rate, veh/h	581	0	103	740	1312	640
Adj No. of Lanes	2	1	1	2	2	1
Peak Hour Factor	0.93	0.93	0.93	0.93	0.93	0.93
Percent Heavy Veh, %	5	0	4	4	4	4
Cap, veh/h	656	307	264	2858	2544	1138
Arrive On Green	0.19	0.00	0.11	1.00	0.73	0.73
Sat Flow, veh/h	3447	1615	1740	3563	3563	1553
Grp Volume(v), veh/h	581	0	103	740	1312	640
Grp Sat Flow(s),veh/h/ln	1723	1615	1740	1736	1736	1553
Q Serve(g_s), s	27.2	0.0	2.1	0.0	26.9	31.1
Cycle Q Clear(g_c), s	27.2	0.0	2.1	0.0	26.9	31.1
Prop In Lane	1.00	1.00	1.00			1.00
Lane Grp Cap(c), veh/h	656	307	264	2858	2544	1138
V/C Ratio(X)	0.89	0.00	0.39	0.26	0.52	0.56
Avail Cap(c_a), veh/h	1248	585	295	2858	2544	1138
HCM Platoon Ratio	1.00	1.00	2.00	2.00	1.00	1.00
Upstream Filter(I)	1.00	0.00	0.84	0.84	1.00	1.00
Uniform Delay (d), s/veh	65.4	0.0	7.6	0.0	9.5	10.1
Incr Delay (d2), s/veh	4.3	0.0	0.8	0.2	0.8	2.0
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	13.4	0.0	1.4	0.1	13.0	13.8
LnGrp Delay(d),s/veh	69.6	0.0	8.4	0.2	10.3	12.1
LnGrp LOS	E		A	A	B	B
Approach Vol, veh/h	581			843	1952	
Approach Delay, s/veh	69.6			1.2	10.9	
Approach LOS	E			A	B	

Timer	1	2	3	4	5	6	7	8
Assigned Phs	1	2				6		8
Phs Duration (G+Y+Rc), s	15.0	127.5				142.5		37.5
Change Period (Y+Rc), s	6.0	6.0				6.0		6.0
Max Green Setting (Gmax), s	12.0	90.0				108.0		60.0
Max Q Clear Time (g_c+I1), s	4.1	33.1				2.0		29.2
Green Ext Time (p_c), s	0.1	32.6				42.1		2.3

Intersection Summary	
HCM 2010 Ctrl Delay	18.6
HCM 2010 LOS	B

Notes

User approved volume balancing among the lanes for turning movement.

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Volume (veh/h)	753	232	58	1082	843	508
Number	3	18	1	6	2	12
Initial Q (Qb), veh	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00	1.00	1.00			1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1810	1900	1845	1845	1827	1827
Adj Flow Rate, veh/h	801	0	62	1151	897	540
Adj No. of Lanes	2	1	1	2	2	1
Peak Hour Factor	0.94	0.94	0.94	0.94	0.94	0.94
Percent Heavy Veh, %	5	0	3	3	4	4
Cap, veh/h	889	417	404	2707	2213	990
Arrive On Green	0.26	0.00	0.20	1.00	0.64	0.64
Sat Flow, veh/h	3447	1615	1757	3597	3563	1553
Grp Volume(v), veh/h	801	0	62	1151	897	540
Grp Sat Flow(s),veh/h/ln	1723	1615	1757	1752	1736	1553
Q Serve(g_s), s	36.6	0.0	1.4	0.0	20.6	31.5
Cycle Q Clear(g_c), s	36.6	0.0	1.4	0.0	20.6	31.5
Prop In Lane	1.00	1.00	1.00			1.00
Lane Grp Cap(c), veh/h	889	417	404	2707	2213	990
V/C Ratio(X)	0.90	0.00	0.15	0.43	0.41	0.55
Avail Cap(c_a), veh/h	1607	753	404	2707	2213	990
HCM Platoon Ratio	1.00	1.00	2.00	2.00	1.00	1.00
Upstream Filter(I)	1.00	0.00	0.80	0.80	1.00	1.00
Uniform Delay (d), s/veh	58.5	0.0	6.4	0.0	14.4	16.4
Incr Delay (d2), s/veh	3.7	0.0	0.1	0.4	0.6	2.2
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	17.9	0.0	0.7	0.1	10.0	14.1
LnGrp Delay(d),s/veh	62.1	0.0	6.6	0.4	15.0	18.6
LnGrp LOS	E		A	A	B	B
Approach Vol, veh/h	801			1213	1437	
Approach Delay, s/veh	62.1			0.7	16.3	
Approach LOS	E			A	B	

Timer	1	2	3	4	5	6	7	8
Assigned Phs	1	2				6		8
Phs Duration (G+Y+Rc), s	22.0	109.9				131.9		48.1
Change Period (Y+Rc), s	6.0	6.0				6.0		6.0
Max Green Setting (Gmax), s	16.0	70.0				92.0		76.0
Max Q Clear Time (g_c+I1), s	3.4	33.5				2.0		38.6
Green Ext Time (p_c), s	0.1	23.8				37.0		3.4

Intersection Summary	
HCM 2010 Ctrl Delay	21.5
HCM 2010 LOS	C

Notes

User approved volume balancing among the lanes for turning movement.

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	24	651	160	28	579	106	14	5	95	12	4	28
Number	1	6	16	5	2	12	7	4	14	3	8	18
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1827	1827	1900	1776	1776	1776	1900	1776	1776	1810	1810	1900
Adj Flow Rate, veh/h	27	723	178	31	643	118	16	6	106	13	4	31
Adj No. of Lanes	1	2	0	1	2	1	0	1	1	1	1	0
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Percent Heavy Veh, %	4	4	4	7	7	7	7	7	7	5	5	5
Cap, veh/h	386	1322	325	313	1614	722	398	130	433	476	51	398
Arrive On Green	0.48	0.48	0.48	0.48	0.48	0.48	0.29	0.29	0.29	0.29	0.29	0.29
Sat Flow, veh/h	689	2763	680	587	3374	1509	964	452	1509	1239	179	1386
Grp Volume(v), veh/h	27	454	447	31	643	118	22	0	106	13	0	35
Grp Sat Flow(s),veh/h/ln	689	1736	1707	587	1687	1509	1417	0	1509	1239	0	1565
Q Serve(g_s), s	1.3	9.5	9.5	2.0	6.3	2.3	0.0	0.0	2.8	0.4	0.0	0.8
Cycle Q Clear(g_c), s	7.6	9.5	9.5	11.5	6.3	2.3	0.8	0.0	2.8	1.2	0.0	0.8
Prop In Lane	1.00		0.40	1.00		1.00	0.73		1.00	1.00		0.89
Lane Grp Cap(c), veh/h	386	831	817	313	1614	722	528	0	433	476	0	449
V/C Ratio(X)	0.07	0.55	0.55	0.10	0.40	0.16	0.04	0.00	0.24	0.03	0.00	0.08
Avail Cap(c_a), veh/h	514	1153	1134	422	2241	1003	564	0	472	508	0	489
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.00	1.00	1.00	0.00	1.00
Uniform Delay (d), s/veh	11.1	9.4	9.4	13.5	8.6	7.5	13.2	0.0	14.0	13.8	0.0	13.3
Incr Delay (d2), s/veh	0.1	0.6	0.6	0.1	0.2	0.1	0.0	0.0	0.3	0.0	0.0	0.1
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	0.3	4.5	4.5	0.3	2.9	0.9	0.2	0.0	1.2	0.1	0.0	0.4
LnGrp Delay(d),s/veh	11.1	10.0	10.0	13.6	8.8	7.7	13.2	0.0	14.3	13.8	0.0	13.4
LnGrp LOS	B	A	B	B	A	A	B		B	B		B
Approach Vol, veh/h		928			792			128			48	
Approach Delay, s/veh		10.0			8.8			14.1			13.5	
Approach LOS		B			A			B			B	

Timer	1	2	3	4	5	6	7	8
Assigned Phs		2		4		6		8
Phs Duration (G+Y+Rc), s		30.5		20.7		30.5		20.7
Change Period (Y+Rc), s		6.0		6.0		6.0		6.0
Max Green Setting (Gmax), s		34.0		16.0		34.0		16.0
Max Q Clear Time (g_c+I1), s		13.5		4.8		11.5		3.2
Green Ext Time (p_c), s		11.0		0.5		11.6		0.5

Intersection Summary	
HCM 2010 Ctrl Delay	9.9
HCM 2010 LOS	A

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	61	595	125	45	523	155	42	5	125	16	6	28
Number	1	6	16	5	2	12	7	4	14	3	8	18
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1863	1863	1900	1863	1863	1863	1900	1827	1827	1863	1863	1900
Adj Flow Rate, veh/h	64	620	130	47	545	161	44	5	130	17	6	29
Adj No. of Lanes	1	2	0	1	2	1	0	1	1	1	1	0
Peak Hour Factor	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96
Percent Heavy Veh, %	2	2	2	2	2	2	4	4	4	2	2	2
Cap, veh/h	400	1297	271	355	1575	705	505	50	483	492	87	419
Arrive On Green	0.44	0.44	0.44	0.44	0.44	0.44	0.31	0.31	0.31	0.31	0.31	0.31
Sat Flow, veh/h	739	2915	610	709	3539	1583	1178	161	1553	1249	279	1347
Grp Volume(v), veh/h	64	376	374	47	545	161	49	0	130	17	0	35
Grp Sat Flow(s),veh/h/ln	739	1770	1755	709	1770	1583	1339	0	1553	1249	0	1625
Q Serve(g_s), s	3.1	7.4	7.4	2.5	5.0	3.1	1.0	0.0	3.1	0.5	0.0	0.7
Cycle Q Clear(g_c), s	8.0	7.4	7.4	9.9	5.0	3.1	1.7	0.0	3.1	2.2	0.0	0.7
Prop In Lane	1.00		0.35	1.00		1.00	0.90		1.00	1.00		0.83
Lane Grp Cap(c), veh/h	400	787	781	355	1575	705	555	0	483	492	0	506
V/C Ratio(X)	0.16	0.48	0.48	0.13	0.35	0.23	0.09	0.00	0.27	0.03	0.00	0.07
Avail Cap(c_a), veh/h	582	1222	1212	530	2445	1094	575	0	505	509	0	528
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.00	1.00	1.00	0.00	1.00
Uniform Delay (d), s/veh	11.6	9.6	9.6	13.1	9.0	8.4	12.3	0.0	12.7	13.1	0.0	11.9
Incr Delay (d2), s/veh	0.2	0.5	0.5	0.2	0.1	0.2	0.1	0.0	0.3	0.0	0.0	0.1
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	0.6	3.6	3.6	0.5	2.5	1.4	0.5	0.0	1.4	0.2	0.0	0.3
LnGrp Delay(d),s/veh	11.8	10.1	10.1	13.3	9.1	8.6	12.4	0.0	13.0	13.1	0.0	12.0
LnGrp LOS	B	B	B	B	A	A	B		B	B		B
Approach Vol, veh/h		814			753			179			52	
Approach Delay, s/veh		10.2			9.2			12.9			12.4	
Approach LOS		B			A			B			B	

Timer	1	2	3	4	5	6	7	8
Assigned Phs		2		4		6		8
Phs Duration (G+Y+Rc), s		27.9		21.3		27.9		21.3
Change Period (Y+Rc), s		6.0		6.0		6.0		6.0
Max Green Setting (Gmax), s		34.0		16.0		34.0		16.0
Max Q Clear Time (g_c+I1), s		11.9		5.1		10.0		4.2
Green Ext Time (p_c), s		10.0		0.7		10.4		0.7

Intersection Summary	
HCM 2010 Ctrl Delay	10.1
HCM 2010 LOS	B

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	17	21	162	62	6	7	498	811	164	18	621	45
Number	3	8	18	7	4	14	1	6	16	5	2	12
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1792	1792	1792	1545	1545	1900	1792	1792	1900	1776	1776	1776
Adj Flow Rate, veh/h	18	23	176	67	7	8	541	882	178	20	675	49
Adj No. of Lanes	1	1	1	1	1	0	2	3	0	1	3	1
Peak Hour Factor	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Percent Heavy Veh, %	6	6	6	23	23	23	6	6	6	7	7	7
Cap, veh/h	488	498	423	388	183	209	580	1489	299	72	1125	350
Arrive On Green	0.28	0.28	0.28	0.28	0.28	0.28	0.18	0.36	0.36	0.04	0.23	0.23
Sat Flow, veh/h	1340	1792	1524	977	659	753	3312	4089	821	1691	4848	1509
Grp Volume(v), veh/h	18	23	176	67	0	15	541	703	357	20	675	49
Grp Sat Flow(s),veh/h/ln	1340	1792	1524	977	0	1412	1656	1631	1648	1691	1616	1509
Q Serve(g_s), s	0.6	0.5	5.4	3.1	0.0	0.4	9.2	10.0	10.0	0.7	7.1	1.5
Cycle Q Clear(g_c), s	1.0	0.5	5.4	3.6	0.0	0.4	9.2	10.0	10.0	0.7	7.1	1.5
Prop In Lane	1.00		1.00	1.00		0.53	1.00		0.50	1.00		1.00
Lane Grp Cap(c), veh/h	488	498	423	388	0	392	580	1188	600	72	1125	350
V/C Ratio(X)	0.04	0.05	0.42	0.17	0.00	0.04	0.93	0.59	0.60	0.28	0.60	0.14
Avail Cap(c_a), veh/h	538	565	480	425	0	445	580	1188	600	266	1528	476
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	1.00	1.00	0.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	15.4	15.1	16.8	16.4	0.0	15.1	23.2	14.7	14.7	26.5	19.6	17.4
Incr Delay (d2), s/veh	0.0	0.0	0.7	0.2	0.0	0.0	22.3	0.8	1.6	2.0	0.5	0.2
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	0.2	0.3	2.3	0.8	0.0	0.2	6.0	4.6	4.8	0.3	3.2	0.6
LnGrp Delay(d),s/veh	15.5	15.1	17.5	16.6	0.0	15.1	45.5	15.5	16.3	28.5	20.1	17.6
LnGrp LOS	B	B	B	B		B	D	B	B	C	C	B
Approach Vol, veh/h		217			82			1601			744	
Approach Delay, s/veh		17.1			16.3			25.8			20.1	
Approach LOS		B			B			C			C	

Timer	1	2	3	4	5	6	7	8
Assigned Phs	1	2		4	5	6		8
Phs Duration (G+Y+Rc), s	16.0	19.3		21.9	8.4	26.8		21.9
Change Period (Y+Rc), s	6.0	6.0		6.0	6.0	6.0		6.0
Max Green Setting (Gmax), s	10.0	18.0		18.0	9.0	19.0		18.0
Max Q Clear Time (g_c+I1), s	11.2	9.1		5.6	2.7	12.0		7.4
Green Ext Time (p_c), s	0.0	3.7		0.9	0.0	5.2		0.8

Intersection Summary	
HCM 2010 Ctrl Delay	23.2
HCM 2010 LOS	C

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	39	4	409	162	10	8	199	734	67	4	650	21
Number	3	8	18	7	4	14	1	6	16	5	2	12
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1863	1863	1863	1776	1776	1900	1863	1863	1900	1845	1845	1845
Adj Flow Rate, veh/h	45	5	470	186	11	9	229	844	77	5	747	24
Adj No. of Lanes	1	1	1	1	1	0	2	3	0	1	3	1
Peak Hour Factor	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87
Percent Heavy Veh, %	2	2	2	7	7	7	2	2	2	3	3	3
Cap, veh/h	543	578	492	393	281	230	521	1742	158	21	1147	357
Arrive On Green	0.31	0.31	0.31	0.31	0.31	0.31	0.15	0.37	0.37	0.01	0.23	0.23
Sat Flow, veh/h	1386	1863	1583	873	905	740	3442	4746	431	1757	5036	1568
Grp Volume(v), veh/h	45	5	470	186	0	20	229	602	319	5	747	24
Grp Sat Flow(s),veh/h/ln	1386	1863	1583	873	0	1645	1721	1695	1787	1757	1679	1568
Q Serve(g_s), s	1.4	0.1	16.9	10.9	0.0	0.5	3.5	7.9	8.0	0.2	7.8	0.7
Cycle Q Clear(g_c), s	1.8	0.1	16.9	11.0	0.0	0.5	3.5	7.9	8.0	0.2	7.8	0.7
Prop In Lane	1.00		1.00	1.00		0.45	1.00		0.24	1.00		1.00
Lane Grp Cap(c), veh/h	543	578	492	393	0	511	521	1244	656	21	1147	357
V/C Ratio(X)	0.08	0.01	0.96	0.47	0.00	0.04	0.44	0.48	0.49	0.24	0.65	0.07
Avail Cap(c_a), veh/h	543	578	492	393	0	511	594	1244	656	273	1563	487
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	1.00	1.00	0.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	14.6	13.8	19.6	17.6	0.0	14.0	22.4	14.1	14.1	28.4	20.3	17.6
Incr Delay (d2), s/veh	0.1	0.0	29.7	0.9	0.0	0.0	0.6	0.3	0.6	5.6	0.6	0.1
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	0.5	0.1	11.4	2.7	0.0	0.2	1.7	3.7	4.0	0.1	3.7	0.3
LnGrp Delay(d),s/veh	14.7	13.8	49.3	18.5	0.0	14.0	23.0	14.4	14.7	34.0	20.9	17.6
LnGrp LOS	B	B	D	B		B	C	B	B	C	C	B
Approach Vol, veh/h		520			206			1150			776	
Approach Delay, s/veh		45.9			18.1			16.2			20.9	
Approach LOS		D			B			B			C	

Timer	1	2	3	4	5	6	7	8
Assigned Phs	1	2		4	5	6		8
Phs Duration (G+Y+Rc), s	14.8	19.2		24.0	6.7	27.3		24.0
Change Period (Y+Rc), s	6.0	6.0		6.0	6.0	6.0		6.0
Max Green Setting (Gmax), s	10.0	18.0		18.0	9.0	19.0		18.0
Max Q Clear Time (g_c+I1), s	5.5	9.8		13.0	2.2	10.0		18.9
Green Ext Time (p_c), s	0.3	3.0		1.5	0.0	6.2		0.0

Intersection Summary	
HCM 2010 Ctrl Delay	23.6
HCM 2010 LOS	C

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	0	0	0	353	0	277	199	1196	0	0	715	130
Number				3	8	18	5	2	12	1	6	16
Initial Q (Qb), veh				0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)				1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj				1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln				1810	0	1810	1712	1712	0	0	1727	1727
Adj Flow Rate, veh/h				401	0	315	226	1359	0	0	812	148
Adj No. of Lanes				2	0	1	2	3	0	0	3	1
Peak Hour Factor				0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88	0.88
Percent Heavy Veh, %				5	0	5	11	11	0	0	10	10
Cap, veh/h				804	0	370	414	2722	0	0	1712	533
Arrive On Green				0.24	0.00	0.24	0.13	0.58	0.00	0.00	0.36	0.36
Sat Flow, veh/h				3343	0	1538	3163	4827	0	0	4871	1468
Grp Volume(v), veh/h				401	0	315	226	1359	0	0	812	148
Grp Sat Flow(s),veh/h/ln				1672	0	1538	1581	1558	0	0	1572	1468
Q Serve(g_s), s				7.0	0.0	13.3	4.5	11.6	0.0	0.0	9.0	4.8
Cycle Q Clear(g_c), s				7.0	0.0	13.3	4.5	11.6	0.0	0.0	9.0	4.8
Prop In Lane				1.00		1.00	1.00		0.00	0.00		1.00
Lane Grp Cap(c), veh/h				804	0	370	414	2722	0	0	1712	533
V/C Ratio(X)				0.50	0.00	0.85	0.55	0.50	0.00	0.00	0.47	0.28
Avail Cap(c_a), veh/h				938	0	431	653	3379	0	0	2018	628
HCM Platoon Ratio				1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)				1.00	0.00	1.00	1.00	1.00	0.00	0.00	1.00	1.00
Uniform Delay (d), s/veh				22.2	0.0	24.6	27.6	8.3	0.0	0.0	16.6	15.3
Incr Delay (d2), s/veh				0.5	0.0	13.5	1.1	0.1	0.0	0.0	0.2	0.3
Initial Q Delay(d3),s/veh				0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln				3.3	0.0	7.0	2.0	4.9	0.0	0.0	3.9	2.0
LnGrp Delay(d),s/veh				22.7	0.0	38.0	28.7	8.5	0.0	0.0	16.8	15.6
LnGrp LOS				C		D	C	A			B	B
Approach Vol, veh/h					716			1585			960	
Approach Delay, s/veh					29.4			11.4			16.6	
Approach LOS					C			B			B	

Timer	1	2	3	4	5	6	7	8
Assigned Phs		2			5	6		8
Phs Duration (G+Y+Rc), s		45.5			14.9	30.6		22.3
Change Period (Y+Rc), s		6.0			6.0	6.0		6.0
Max Green Setting (Gmax), s		49.0			14.0	29.0		19.0
Max Q Clear Time (g_c+I1), s		13.6			6.5	11.0		15.3
Green Ext Time (p_c), s		22.0			0.4	13.6		1.0

Intersection Summary	
HCM 2010 Ctrl Delay	16.9
HCM 2010 LOS	B

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	0	0	0	498	0	205	477	795	0	0	1012	209
Number				3	8	18	5	2	12	1	6	16
Initial Q (Qb), veh				0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)				1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj				1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln				1863	0	1863	1863	1863	0	0	1845	1845
Adj Flow Rate, veh/h				541	0	223	518	864	0	0	1100	227
Adj No. of Lanes				2	0	1	2	3	0	0	3	1
Peak Hour Factor				0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Percent Heavy Veh, %				2	0	2	2	2	0	0	3	3
Cap, veh/h				692	0	319	619	3189	0	0	1821	567
Arrive On Green				0.20	0.00	0.20	0.18	0.63	0.00	0.00	0.36	0.36
Sat Flow, veh/h				3442	0	1583	3442	5253	0	0	5202	1568
Grp Volume(v), veh/h				541	0	223	518	864	0	0	1100	227
Grp Sat Flow(s),veh/h/ln				1721	0	1583	1721	1695	0	0	1679	1568
Q Serve(g_s), s				10.4	0.0	9.2	10.2	5.3	0.0	0.0	12.5	7.6
Cycle Q Clear(g_c), s				10.4	0.0	9.2	10.2	5.3	0.0	0.0	12.5	7.6
Prop In Lane				1.00		1.00	1.00		0.00	0.00		1.00
Lane Grp Cap(c), veh/h				692	0	319	619	3189	0	0	1821	567
V/C Ratio(X)				0.78	0.00	0.70	0.84	0.27	0.00	0.00	0.60	0.40
Avail Cap(c_a), veh/h				935	0	430	689	3565	0	0	2089	651
HCM Platoon Ratio				1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)				1.00	0.00	1.00	1.00	1.00	0.00	0.00	1.00	1.00
Uniform Delay (d), s/veh				26.5	0.0	26.0	27.7	5.9	0.0	0.0	18.2	16.7
Incr Delay (d2), s/veh				3.1	0.0	3.2	8.2	0.0	0.0	0.0	0.4	0.5
Initial Q Delay(d3),s/veh				0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln				5.3	0.0	4.2	5.5	2.5	0.0	0.0	5.8	3.4
LnGrp Delay(d),s/veh				29.5	0.0	29.1	35.9	5.9	0.0	0.0	18.6	17.1
LnGrp LOS				C		C	D	A			B	B
Approach Vol, veh/h					764			1382			1327	
Approach Delay, s/veh					29.4			17.1			18.4	
Approach LOS					C			B			B	

Timer	1	2	3	4	5	6	7	8
Assigned Phs		2			5	6		8
Phs Duration (G+Y+Rc), s		49.8			18.6	31.3		20.1
Change Period (Y+Rc), s		6.0			6.0	6.0		6.0
Max Green Setting (Gmax), s		49.0			14.0	29.0		19.0
Max Q Clear Time (g_c+I1), s		7.3			12.2	14.5		12.4
Green Ext Time (p_c), s		21.5			0.4	10.8		1.6

Intersection Summary	
HCM 2010 Ctrl Delay	20.3
HCM 2010 LOS	C

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	7	75	238	64	37	8	218	256	196	4	132	23
Number	7	4	14	3	8	18	5	2	12	1	6	16
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1900	1810	1810	1776	1776	1900	1827	1827	1827	1900	1776	1900
Adj Flow Rate, veh/h	7	80	253	68	39	9	232	272	209	4	140	24
Adj No. of Lanes	0	1	1	1	1	0	1	1	1	0	2	0
Peak Hour Factor	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94
Percent Heavy Veh, %	5	5	5	7	7	7	4	4	4	7	7	7
Cap, veh/h	64	390	535	441	559	129	534	789	671	57	627	104
Arrive On Green	0.22	0.22	0.22	0.09	0.40	0.40	0.12	0.43	0.43	0.22	0.22	0.22
Sat Flow, veh/h	45	1748	1538	1691	1397	322	1740	1827	1553	20	2805	465
Grp Volume(v), veh/h	87	0	253	68	0	48	232	272	209	89	0	79
Grp Sat Flow(s),veh/h/ln	1793	0	1538	1691	0	1719	1740	1827	1553	1755	0	1534
Q Serve(g_s), s	0.0	0.0	9.2	2.0	0.0	1.2	6.9	7.1	6.3	0.0	0.0	3.0
Cycle Q Clear(g_c), s	2.8	0.0	9.2	2.0	0.0	1.2	6.9	7.1	6.3	2.9	0.0	3.0
Prop In Lane	0.08		1.00	1.00		0.19	1.00		1.00	0.05		0.30
Lane Grp Cap(c), veh/h	455	0	535	441	0	688	534	789	671	445	0	343
V/C Ratio(X)	0.19	0.00	0.47	0.15	0.00	0.07	0.43	0.34	0.31	0.20	0.00	0.23
Avail Cap(c_a), veh/h	455	0	535	496	0	744	536	995	846	634	0	514
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	0.00	1.00	1.00	0.00	1.00	1.00	1.00	1.00	1.00	0.00	1.00
Uniform Delay (d), s/veh	22.7	0.0	18.2	16.2	0.0	13.2	16.3	13.6	13.3	22.7	0.0	22.8
Incr Delay (d2), s/veh	0.2	0.0	0.6	0.2	0.0	0.0	0.6	0.3	0.3	0.2	0.0	0.3
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	1.4	0.0	3.9	0.9	0.0	0.6	3.3	3.6	2.8	1.5	0.0	1.3
LnGrp Delay(d),s/veh	22.9	0.0	18.9	16.4	0.0	13.3	16.9	13.8	13.6	22.9	0.0	23.1
LnGrp LOS	C		B	B		B	B	B	B	C		C
Approach Vol, veh/h		340			116			713			168	
Approach Delay, s/veh		19.9			15.1			14.8			23.0	
Approach LOS		B			B			B			C	

Timer	1	2	3	4	5	6	7	8
Assigned Phs		2	3	4	5	6		8
Phs Duration (G+Y+Rc), s		36.9	12.7	22.0	14.9	22.0		34.7
Change Period (Y+Rc), s		6.0	6.0	6.0	6.0	6.0		6.0
Max Green Setting (Gmax), s		39.0	9.0	16.0	9.0	24.0		31.0
Max Q Clear Time (g_c+I1), s		9.1	4.0	11.2	8.9	5.0		3.2
Green Ext Time (p_c), s		3.4	0.0	0.7	0.0	3.1		1.6

Intersection Summary	
HCM 2010 Ctrl Delay	17.1
HCM 2010 LOS	B

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	9	46	387	175	64	6	236	225	140	4	312	23
Number	7	4	14	3	8	18	5	2	12	1	6	16
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1900	1845	1845	1863	1863	1900	1845	1845	1845	1900	1845	1900
Adj Flow Rate, veh/h	9	48	403	182	67	6	246	234	146	4	325	24
Adj No. of Lanes	0	1	1	1	1	0	1	1	1	0	2	0
Peak Hour Factor	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96
Percent Heavy Veh, %	3	3	3	2	2	2	3	3	3	3	3	3
Cap, veh/h	86	358	531	488	703	63	442	775	659	52	700	51
Arrive On Green	0.22	0.22	0.22	0.12	0.42	0.42	0.12	0.42	0.42	0.22	0.22	0.22
Sat Flow, veh/h	137	1651	1568	1774	1685	151	1757	1845	1568	10	3227	235
Grp Volume(v), veh/h	57	0	403	182	0	73	246	234	146	186	0	167
Grp Sat Flow(s),veh/h/ln	1788	0	1568	1774	0	1836	1757	1845	1568	1836	0	1637
Q Serve(g_s), s	0.0	0.0	16.0	5.4	0.0	1.8	7.6	6.2	4.4	0.0	0.0	6.6
Cycle Q Clear(g_c), s	1.8	0.0	16.0	5.4	0.0	1.8	7.6	6.2	4.4	6.5	0.0	6.6
Prop In Lane	0.16		1.00	1.00		0.08	1.00		1.00	0.02		0.14
Lane Grp Cap(c), veh/h	444	0	531	488	0	766	442	775	659	448	0	355
V/C Ratio(X)	0.13	0.00	0.76	0.37	0.00	0.10	0.56	0.30	0.22	0.42	0.00	0.47
Avail Cap(c_a), veh/h	444	0	531	494	0	771	442	975	829	644	0	533
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	0.00	1.00	1.00	0.00	1.00	1.00	1.00	1.00	1.00	0.00	1.00
Uniform Delay (d), s/veh	23.3	0.0	21.7	16.8	0.0	13.0	17.9	14.2	13.7	25.2	0.0	25.2
Incr Delay (d2), s/veh	0.1	0.0	6.3	0.5	0.0	0.1	1.5	0.2	0.2	0.6	0.0	1.0
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	1.0	0.0	8.2	2.6	0.0	0.9	3.8	3.2	1.9	3.4	0.0	3.1
LnGrp Delay(d),s/veh	23.5	0.0	28.0	17.3	0.0	13.1	19.4	14.4	13.8	25.8	0.0	26.2
LnGrp LOS	C		C	B		B	B	B	B	C		C
Approach Vol, veh/h		460			255			626			353	
Approach Delay, s/veh		27.4			16.1			16.3			26.0	
Approach LOS		C			B			B			C	

Timer	1	2	3	4	5	6	7	8
Assigned Phs		2	3	4	5	6		8
Phs Duration (G+Y+Rc), s		37.0	14.8	22.0	15.0	22.0		36.8
Change Period (Y+Rc), s		6.0	6.0	6.0	6.0	6.0		6.0
Max Green Setting (Gmax), s		39.0	9.0	16.0	9.0	24.0		31.0
Max Q Clear Time (g_c+I1), s		8.2	7.4	18.0	9.6	8.6		3.8
Green Ext Time (p_c), s		4.1	0.1	0.0	0.0	3.5		2.2

Intersection Summary	
HCM 2010 Ctrl Delay	21.3
HCM 2010 LOS	C

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	115	648	0	0	367	97	293	0	46	0	0	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	6.0	6.0			6.0		6.0		6.0			
Lane Util. Factor	1.00	0.95			0.95		0.97		1.00			
Frt	1.00	1.00			0.97		1.00		0.85			
Flt Protected	0.95	1.00			1.00		0.95		1.00			
Satd. Flow (prot)	1719	3438			3299		3303		1524			
Flt Permitted	0.40	1.00			1.00		0.95		1.00			
Satd. Flow (perm)	721	3438			3299		3303		1524			
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	125	704	0	0	399	105	318	0	50	0	0	0
RTOR Reduction (vph)	0	0	0	0	26	0	0	0	44	0	0	0
Lane Group Flow (vph)	125	704	0	0	478	0	318	0	6	0	0	0
Heavy Vehicles (%)	5%	5%	5%	6%	6%	6%	6%	6%	6%	2%	2%	2%
Turn Type	custom	NA			NA		Prot		Prot			
Protected Phases	5 8	2 5 8			6		7		7			
Permitted Phases	2						7		7			
Actuated Green, G (s)	62.1	68.1			31.0		11.9		11.9			
Effective Green, g (s)	62.1	68.1			31.0		11.9		11.9			
Actuated g/C Ratio	0.68	0.74			0.34		0.13		0.13			
Clearance Time (s)					6.0		6.0		6.0			
Vehicle Extension (s)					3.0		3.0		3.0			
Lane Grp Cap (vph)	824	2544			1111		427		197			
v/s Ratio Prot	0.05	c0.20			c0.14		c0.10		0.00			
v/s Ratio Perm	0.05											
v/c Ratio	0.15	0.28			0.43		0.74		0.03			
Uniform Delay, d1	5.4	3.9			23.7		38.6		35.0			
Progression Factor	0.69	0.80			1.00		1.00		1.00			
Incremental Delay, d2	0.1	0.1			0.3		6.9		0.1			
Delay (s)	3.8	3.2			23.9		45.5		35.1			
Level of Service	A	A			C		D		D			
Approach Delay (s)		3.3			23.9			44.1			0.0	
Approach LOS		A			C			D			A	

Intersection Summary			
HCM 2000 Control Delay	18.2	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity ratio	0.47		
Actuated Cycle Length (s)	92.0	Sum of lost time (s)	24.0
Intersection Capacity Utilization	71.3%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	241	616	0	0	659	264	299	0	91	0	0	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	6.0	6.0			6.0		6.0		6.0			
Lane Util. Factor	1.00	0.95			0.95		0.97		1.00			
Frt	1.00	1.00			0.96		1.00		0.85			
Flt Protected	0.95	1.00			1.00		0.95		1.00			
Satd. Flow (prot)	1736	3471			3322		3400		1568			
Flt Permitted	0.15	1.00			1.00		0.95		1.00			
Satd. Flow (perm)	270	3471			3322		3400		1568			
Peak-hour factor, PHF	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94	0.94
Adj. Flow (vph)	256	655	0	0	701	281	318	0	97	0	0	0
RTOR Reduction (vph)	0	0	0	0	43	0	0	0	85	0	0	0
Lane Group Flow (vph)	256	655	0	0	939	0	318	0	12	0	0	0
Heavy Vehicles (%)	4%	4%	4%	4%	4%	4%	3%	3%	3%	2%	2%	2%
Turn Type	custom	NA			NA		Prot		Prot			
Protected Phases	5 8	2 5 8			6		7		7			
Permitted Phases	2						7		7			
Actuated Green, G (s)	67.1	73.1			36.8		11.6		11.6			
Effective Green, g (s)	67.1	73.1			36.8		11.6		11.6			
Actuated g/C Ratio	0.69	0.76			0.38		0.12		0.12			
Clearance Time (s)					6.0		6.0		6.0			
Vehicle Extension (s)					3.0		3.0		3.0			
Lane Grp Cap (vph)	646	2623			1264		407		188			
v/s Ratio Prot	c0.12	0.19			c0.28		c0.09		0.01			
v/s Ratio Perm	0.15											
v/c Ratio	0.40	0.25			0.74		0.78		0.06			
Uniform Delay, d1	8.6	3.5			25.9		41.3		37.7			
Progression Factor	2.85	0.70			1.00		1.00		1.00			
Incremental Delay, d2	0.4	0.0			2.4		9.4		0.1			
Delay (s)	24.9	2.5			28.3		50.7		37.9			
Level of Service	C	A			C		D		D			
Approach Delay (s)		8.8			28.3			47.7			0.0	
Approach LOS		A			C			D			A	

Intersection Summary			
HCM 2000 Control Delay	24.1	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.67		
Actuated Cycle Length (s)	96.7	Sum of lost time (s)	24.0
Intersection Capacity Utilization	63.5%	ICU Level of Service	B
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	500	552	50	610	0	0	0	0	263	0	221
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		6.0	6.0	6.0	6.0					6.0		6.0
Lane Util. Factor		0.95	1.00	1.00	0.95					1.00		1.00
Frt		1.00	0.85	1.00	1.00					1.00		0.85
Flt Protected		1.00	1.00	0.95	1.00					0.95		1.00
Satd. Flow (prot)		3438	1538	1671	3343					1671		1495
Flt Permitted		1.00	1.00	0.37	1.00					0.95		1.00
Satd. Flow (perm)		3438	1538	656	3343					1671		1495
Peak-hour factor, PHF	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93	0.93
Adj. Flow (vph)	0	538	594	54	656	0	0	0	0	283	0	238
RTOR Reduction (vph)	0	0	136	0	0	0	0	0	0	0	0	141
Lane Group Flow (vph)	0	538	458	54	656	0	0	0	0	283	0	97
Heavy Vehicles (%)	5%	5%	5%	8%	8%	8%	2%	2%	2%	8%	8%	8%
Turn Type		NA	custom	custom	NA					custom		custom
Protected Phases		2		1	1 6					7 8		7 8
Permitted Phases			2 7 8	6						7 8		7 8
Actuated Green, G (s)		31.0	70.9	40.1	46.1					33.9		33.9
Effective Green, g (s)		31.0	70.9	40.1	46.1					33.9		33.9
Actuated g/C Ratio		0.34	0.77	0.44	0.50					0.37		0.37
Clearance Time (s)		6.0		6.0								
Vehicle Extension (s)		3.0		3.0								
Lane Grp Cap (vph)		1158	1185	386	1675					615		550
v/s Ratio Prot		c0.16		0.01	c0.20					c0.17		0.06
v/s Ratio Perm			0.30	0.05								
v/c Ratio		0.46	0.39	0.14	0.39					0.46		0.18
Uniform Delay, d1		24.0	3.4	15.3	14.2					22.1		19.6
Progression Factor		1.00	1.00	1.29	1.21					1.00		1.00
Incremental Delay, d2		0.3	0.2	0.1	0.1					0.5		0.2
Delay (s)		24.3	3.7	19.8	17.4					22.6		19.8
Level of Service		C	A	B	B					C		B
Approach Delay (s)		13.5			17.6			0.0			21.3	
Approach LOS		B			B			A			C	

Intersection Summary			
HCM 2000 Control Delay	16.4	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity ratio	0.51		
Actuated Cycle Length (s)	92.0	Sum of lost time (s)	24.0
Intersection Capacity Utilization	71.3%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	693	389	88	870	0	0	0	0	164	0	163
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		6.0	6.0	6.0	6.0					6.0		6.0
Lane Util. Factor		0.95	1.00	1.00	0.95					1.00		1.00
Frt		1.00	0.85	1.00	1.00					1.00		0.85
Flt Protected		1.00	1.00	0.95	1.00					0.95		1.00
Satd. Flow (prot)		3505	1568	1736	3471					1556		1392
Flt Permitted		1.00	1.00	0.27	1.00					0.95		1.00
Satd. Flow (perm)		3505	1568	501	3471					1556		1392
Peak-hour factor, PHF	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96	0.96
Adj. Flow (vph)	0	722	405	92	906	0	0	0	0	171	0	170
RTOR Reduction (vph)	0	0	88	0	0	0	0	0	0	0	0	79
Lane Group Flow (vph)	0	722	317	92	906	0	0	0	0	171	0	91
Heavy Vehicles (%)	3%	3%	3%	4%	4%	4%	2%	2%	2%	16%	16%	16%
Turn Type		NA	custom	custom	NA					custom		custom
Protected Phases		2		1	1 6					7 8		7 8
Permitted Phases			2 7 8	6						7 8		7 8
Actuated Green, G (s)		36.8	75.7	45.8	51.8					32.9		32.9
Effective Green, g (s)		36.8	75.7	45.8	51.8					32.9		32.9
Actuated g/C Ratio		0.38	0.78	0.47	0.54					0.34		0.34
Clearance Time (s)		6.0		6.0								
Vehicle Extension (s)		3.0		3.0								
Lane Grp Cap (vph)		1333	1227	352	1859					529		473
v/s Ratio Prot		c0.21		0.02	c0.26					c0.11		0.07
v/s Ratio Perm			0.20	0.10								
v/c Ratio		0.54	0.26	0.26	0.49					0.32		0.19
Uniform Delay, d1		23.4	2.9	14.7	14.1					23.6		22.5
Progression Factor		1.00	1.00	1.03	0.92					1.00		1.00
Incremental Delay, d2		0.5	0.1	0.3	0.1					0.4		0.2
Delay (s)		23.8	3.0	15.5	13.1					24.0		22.7
Level of Service		C	A	B	B					C		C
Approach Delay (s)		16.3			13.3			0.0			23.4	
Approach LOS		B			B			A			C	

Intersection Summary			
HCM 2000 Control Delay	16.1	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity ratio	0.50		
Actuated Cycle Length (s)	96.7	Sum of lost time (s)	24.0
Intersection Capacity Utilization	63.5%	ICU Level of Service	B
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	122	169	216	146	90	48	359	893	215	29	474	67
Number	3	8	18	7	4	14	1	6	16	5	2	12
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1743	1743	1743	1712	1712	1900	1845	1845	1845	1743	1743	1743
Adj Flow Rate, veh/h	134	186	237	160	99	53	395	981	236	32	521	74
Adj No. of Lanes	1	2	1	1	2	0	1	2	1	1	2	1
Peak Hour Factor	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91	0.91
Percent Heavy Veh, %	9	9	9	11	11	11	3	3	3	9	9	9
Cap, veh/h	322	667	466	405	811	408	402	1621	725	199	907	406
Arrive On Green	0.20	0.20	0.20	0.11	0.39	0.39	0.11	0.46	0.46	0.27	0.27	0.27
Sat Flow, veh/h	1151	3312	1482	1630	2097	1055	1757	3505	1568	428	3312	1482
Grp Volume(v), veh/h	134	186	237	160	75	77	395	981	236	32	521	74
Grp Sat Flow(s),veh/h/ln	1151	1656	1482	1630	1626	1526	1757	1752	1568	428	1656	1482
Q Serve(g_s), s	8.4	3.8	10.4	5.7	2.4	2.6	9.0	16.6	7.6	4.8	10.8	3.0
Cycle Q Clear(g_c), s	8.4	3.8	10.4	5.7	2.4	2.6	9.0	16.6	7.6	6.4	10.8	3.0
Prop In Lane	1.00		1.00	1.00		0.69	1.00		1.00	1.00		1.00
Lane Grp Cap(c), veh/h	322	667	466	405	629	590	402	1621	725	199	907	406
V/C Ratio(X)	0.42	0.28	0.51	0.39	0.12	0.13	0.98	0.61	0.33	0.16	0.57	0.18
Avail Cap(c_a), veh/h	322	667	466	411	634	595	402	1808	809	222	1083	485
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	28.7	26.9	22.2	19.7	15.7	15.7	24.0	16.0	13.5	23.9	24.9	22.1
Incr Delay (d2), s/veh	0.9	0.2	0.9	0.6	0.1	0.1	40.5	0.5	0.3	0.4	0.6	0.2
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	2.7	1.8	4.4	2.6	1.1	1.1	10.5	8.1	3.3	0.6	5.0	1.3
LnGrp Delay(d),s/veh	29.6	27.1	23.2	20.3	15.8	15.8	64.4	16.4	13.8	24.3	25.5	22.3
LnGrp LOS	C	C	C	C	B	B	E	B	B	C	C	C
Approach Vol, veh/h		557			312			1612			627	
Approach Delay, s/veh		26.0			18.1			27.8			25.0	
Approach LOS		C			B			C			C	

Timer	1	2	3	4	5	6	7	8
Assigned Phs	1	2		4		6	7	8
Phs Duration (G+Y+Rc), s	15.0	27.8		36.7		42.8	14.7	22.0
Change Period (Y+Rc), s	6.0	6.0		6.0		6.0	6.0	6.0
Max Green Setting (Gmax), s	9.0	26.0		31.0		41.0	9.0	16.0
Max Q Clear Time (g_c+I1), s	11.0	12.8		4.6		18.6	7.7	12.4
Green Ext Time (p_c), s	0.0	9.0		3.5		12.9	0.1	1.2

Intersection Summary	
HCM 2010 Ctrl Delay	25.9
HCM 2010 LOS	C

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	76	112	490	250	271	54	300	707	134	18	904	90
Number	3	8	18	7	4	14	1	6	16	5	2	12
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1863	1863	1863	1810	1810	1900	1845	1845	1845	1863	1863	1863
Adj Flow Rate, veh/h	87	129	563	287	311	62	345	813	154	21	1039	103
Adj No. of Lanes	1	2	1	1	2	0	1	2	1	1	2	1
Peak Hour Factor	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87	0.87
Percent Heavy Veh, %	2	2	2	5	5	5	3	3	3	2	2	2
Cap, veh/h	277	674	471	387	1057	208	285	1711	765	265	1095	490
Arrive On Green	0.19	0.19	0.19	0.11	0.37	0.37	0.11	0.49	0.49	0.31	0.31	0.31
Sat Flow, veh/h	1005	3539	1583	1723	2865	564	1757	3505	1568	579	3539	1583
Grp Volume(v), veh/h	87	129	563	287	185	188	345	813	154	21	1039	103
Grp Sat Flow(s),veh/h/ln	1005	1770	1583	1723	1719	1710	1757	1752	1568	579	1770	1583
Q Serve(g_s), s	6.4	2.6	16.0	9.0	6.4	6.5	9.0	13.0	4.7	2.2	24.1	4.0
Cycle Q Clear(g_c), s	6.4	2.6	16.0	9.0	6.4	6.5	9.0	13.0	4.7	2.2	24.1	4.0
Prop In Lane	1.00		1.00	1.00		0.33	1.00		1.00	1.00		1.00
Lane Grp Cap(c), veh/h	277	674	471	387	634	631	285	1711	765	265	1095	490
V/C Ratio(X)	0.31	0.19	1.19	0.74	0.29	0.30	1.21	0.48	0.20	0.08	0.95	0.21
Avail Cap(c_a), veh/h	277	674	471	387	634	631	285	1711	765	265	1095	490
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	30.1	28.6	29.5	24.9	18.7	18.8	20.5	14.3	12.2	20.8	28.3	21.4
Incr Delay (d2), s/veh	0.6	0.1	106.9	7.5	0.3	0.3	122.9	0.2	0.1	0.1	16.3	0.2
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	1.8	1.3	24.9	2.9	3.1	3.1	16.3	6.3	2.0	0.4	14.2	1.8
LnGrp Delay(d),s/veh	30.8	28.7	136.4	32.4	19.0	19.0	143.4	14.5	12.3	20.9	44.7	21.6
LnGrp LOS	C	C	F	C	B	B	F	B	B	C	D	C
Approach Vol, veh/h		779			660			1312			1163	
Approach Delay, s/veh		106.7			24.8			48.2			42.2	
Approach LOS		F			C			D			D	

Timer	1	2	3	4	5	6	7	8
Assigned Phs	1	2		4		6	7	8
Phs Duration (G+Y+Rc), s	15.0	32.0		37.0		47.0	15.0	22.0
Change Period (Y+Rc), s	6.0	6.0		6.0		6.0	6.0	6.0
Max Green Setting (Gmax), s	9.0	26.0		31.0		41.0	9.0	16.0
Max Q Clear Time (g_c+I1), s	11.0	26.1		8.5		15.0	11.0	18.0
Green Ext Time (p_c), s	0.0	0.0		5.9		16.5	0.0	0.0

Intersection Summary	
HCM 2010 Ctrl Delay	54.1
HCM 2010 LOS	D

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (veh/h)	4	56	48	16	708	4
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90
Hourly flow rate (vph)	4	62	53	18	787	4
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type		None	None			
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	71				102	36
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	71				102	36
tC, single (s)	4.6				7.1	7.2
tC, 2 stage (s)						
tF (s)	2.5				3.7	3.5
p0 queue free %	100				6	100
cM capacity (veh/h)	1363				841	983

Direction, Lane #	EB 1	EB 2	EB 3	WB 1	WB 2	SB 1	SB 2
Volume Total	4	31	31	36	36	524	267
Volume Left	4	0	0	0	0	524	262
Volume Right	0	0	0	0	18	0	4
cSH	1363	1700	1700	1700	1700	841	843
Volume to Capacity	0.00	0.02	0.02	0.02	0.02	0.62	0.32
Queue Length 95th (ft)	0	0	0	0	0	112	34
Control Delay (s)	7.7	0.0	0.0	0.0	0.0	16.1	11.2
Lane LOS	A					C	B
Approach Delay (s)	0.5			0.0		14.5	
Approach LOS						B	

Intersection Summary			
Average Delay	12.4		
Intersection Capacity Utilization	30.3%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (veh/h)	4	8	543	58	60	4
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90
Hourly flow rate (vph)	4	9	603	64	67	4
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type		None	None			
Median storage veh)						
Upstream signal (ft)						
pX, platoon unblocked						
vC, conflicting volume	668				649	334
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	668				649	334
tC, single (s)	4.6				7.2	7.3
tC, 2 stage (s)						
tF (s)	2.5				3.7	3.5
p0 queue free %	99				82	99
cM capacity (veh/h)	779				362	612

Direction, Lane #	EB 1	EB 2	EB 3	WB 1	WB 2	SB 1	SB 2
Volume Total	4	4	4	402	266	44	27
Volume Left	4	0	0	0	0	44	22
Volume Right	0	0	0	0	64	0	4
cSH	779	1700	1700	1700	1700	362	389
Volume to Capacity	0.01	0.00	0.00	0.24	0.16	0.12	0.07
Queue Length 95th (ft)	0	0	0	0	0	10	6
Control Delay (s)	9.6	0.0	0.0	0.0	0.0	16.3	14.9
Lane LOS	A					C	B
Approach Delay (s)	3.2			0.0		15.8	
Approach LOS						C	

Intersection Summary			
Average Delay	1.6		
Intersection Capacity Utilization	26.9%	ICU Level of Service	A
Analysis Period (min)	15		

Intersection	
Int Delay, s/veh	2.6

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR
Vol, veh/h	0	0	52	0	0	16	0	143	712
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0
Sign Control	Stop	Stop	Stop	Stop	Stop	Stop	Free	Free	Free
RT Channelized	-	-	Yield	-	-	Yield	-	-	Free
Storage Length	-	-	0	-	-	0	125	-	0
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-
Peak Hour Factor	90	90	90	90	90	90	90	90	90
Heavy Vehicles, %	13	13	13	25	25	25	15	15	15
Mvmt Flow	0	0	58	0	0	18	0	159	791

Major/Minor	Minor2			Minor1			Major1		
Conflicting Flow All	98	178	19	178	178	79	19	0	-
Stage 1	19	19	-	159	159	-	-	-	-
Stage 2	79	159	-	19	19	-	-	-	-
Critical Hdwy	7.495	6.695	6.395	7.675	6.875	7.275	4.25	-	-
Critical Hdwy Stg 1	6.295	5.695	-	6.875	5.875	-	-	-	-
Critical Hdwy Stg 2	6.695	5.695	-	6.475	5.875	-	-	-	-
Follow-up Hdwy	3.6235	4.1235	3.4235	3.7375	4.2375	3.5375	2.335	-	-
Pot Cap-1 Maneuver	851	693	1026	722	670	902	1517	-	0
Stage 1	970	856	-	771	719	-	-	-	0
Stage 2	892	743	-	940	833	-	-	-	0
Platoon blocked, %								-	
Mov Cap-1 Maneuver	834	693	1026	681	670	902	1517	-	-
Mov Cap-2 Maneuver	834	693	-	681	670	-	-	-	-
Stage 1	970	856	-	771	719	-	-	-	-
Stage 2	874	743	-	887	833	-	-	-	-

Approach	EB	WB	NB
HCM Control Delay, s	8.7	9.1	
HCM LOS	A	A	

Minor Lane/Major Mvmt	NBL	NBT	EBLn1	WBLn1	SBL	SBT
Capacity (veh/h)	1517	-	1026	902	1348	-
HCM Lane V/C Ratio	-	-	0.056	0.02	-	-
HCM Control Delay (s)	0	-	8.7	9.1	0	-
HCM Lane LOS	A	-	A	A	A	-
HCM 95th %tile Q(veh)	0	-	0	0	0	-

Intersection			
Int Delay, s/veh			

Movement	SBL	SBT	SBR
Vol, veh/h	0	17	60
Conflicting Peds, #/hr	0	0	0
Sign Control	Free	Free	Free
RT Channelized	-	-	Free
Storage Length	-	-	-
Veh in Median Storage, #	-	0	-
Grade, %	-	0	-
Peak Hour Factor	90	90	90
Heavy Vehicles, %	12	12	12
Mvmt Flow	0	19	67

Major/Minor	Major2		
Conflicting Flow All	159	0	0
Stage 1	-	-	-
Stage 2	-	-	-
Critical Hdwy	4.34	-	-
Critical Hdwy Stg 1	-	-	-
Critical Hdwy Stg 2	-	-	-
Follow-up Hdwy	2.32	-	-
Pot Cap-1 Maneuver	1348	-	0
Stage 1	-	-	0
Stage 2	-	-	0
Platoon blocked, %		-	
Mov Cap-1 Maneuver	1348	-	-
Mov Cap-2 Maneuver	-	-	-
Stage 1	-	-	-
Stage 2	-	-	-

Approach	SB
HCM Control Delay, s	
HCM LOS	

Minor Lane/Major Mvmt

Intersection	
Int Delay, s/veh	13.5

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR
Vol, veh/h	0	0	547	0	0	58	0	28	60
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0
Sign Control	Stop	Stop	Stop	Stop	Stop	Stop	Free	Free	Free
RT Channelized	-	-	Yield	-	-	Yield	-	-	Free
Storage Length	-	-	0	-	-	0	125	-	0
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-
Peak Hour Factor	90	90	90	90	90	90	90	90	90
Heavy Vehicles, %	14	14	14	5	5	5	14	14	14
Mvmt Flow	0	0	608	0	0	64	0	31	67

Major/Minor	Minor2			Minor1			Major1		
Conflicting Flow All	147	162	131	162	162	16	131	0	-
Stage 1	131	131	-	31	31	-	-	-	-
Stage 2	16	31	-	131	131	-	-	-	-
Critical Hdwy	7.51	6.71	6.41	7.375	6.575	6.975	4.24	-	-
Critical Hdwy Stg 1	6.31	5.71	-	6.575	5.575	-	-	-	-
Critical Hdwy Stg 2	6.71	5.71	-	6.175	5.575	-	-	-	-
Follow-up Hdwy	3.633	4.133	3.433	3.5475	4.0475	3.3475	2.326	-	-
Pot Cap-1 Maneuver	785	706	883	788	724	1050	1383	-	0
Stage 1	841	762	-	974	863	-	-	-	0
Stage 2	970	844	-	864	781	-	-	-	0
Platoon blocked, %								-	
Mov Cap-1 Maneuver	737	706	883	246	724	1050	1383	-	-
Mov Cap-2 Maneuver	737	706	-	246	724	-	-	-	-
Stage 1	841	762	-	974	863	-	-	-	-
Stage 2	910	844	-	269	781	-	-	-	-

Approach	EB	WB	NB
HCM Control Delay, s	17.6	8.7	
HCM LOS	C	A	

Minor Lane/Major Mvmt	NBL	NBT	EBLn1	WBLn1	SBL	SBT
Capacity (veh/h)	1383	-	883	1050	1510	-
HCM Lane V/C Ratio	-	-	0.688	0.061	-	-
HCM Control Delay (s)	0	-	17.6	8.7	0	-
HCM Lane LOS	A	-	C	A	A	-
HCM 95th %tile Q(veh)	0	-	6	0	0	-

Intersection			
Int Delay, s/veh			

Movement	SBL	SBT	SBR
Vol, veh/h	0	118	12
Conflicting Peds, #/hr	0	0	0
Sign Control	Free	Free	Free
RT Channelized	-	-	Free
Storage Length	-	-	-
Veh in Median Storage, #	-	0	-
Grade, %	-	0	-
Peak Hour Factor	90	90	90
Heavy Vehicles, %	12	12	12
Mvmt Flow	0	131	13

Major/Minor	Major2		
Conflicting Flow All	31	0	0
Stage 1	-	-	-
Stage 2	-	-	-
Critical Hdwy	4.34	-	-
Critical Hdwy Stg 1	-	-	-
Critical Hdwy Stg 2	-	-	-
Follow-up Hdwy	2.32	-	-
Pot Cap-1 Maneuver	1510	-	0
Stage 1	-	-	0
Stage 2	-	-	0
Platoon blocked, %		-	
Mov Cap-1 Maneuver	1510	-	-
Mov Cap-2 Maneuver	-	-	-
Stage 1	-	-	-
Stage 2	-	-	-

Approach	SB
HCM Control Delay, s	
HCM LOS	

Minor Lane/Major Mvmt

Intersection	
Int Delay, s/veh	0.5

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Vol, veh/h	4	71	6	4	140	19
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Stop	Stop	Free	Free
RT Channelized	-	Free	-	None	-	Yield
Storage Length	-	0	-	-	0	0
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	77	77	77	77	77	77
Heavy Vehicles, %	2	2	2	2	5	5
Mvmt Flow	5	92	8	5	182	25

Major/Minor	Major1		Minor2		Major2	
Conflicting Flow All	0	-	5	369	5	-
Stage 1	-	-	0	364	-	-
Stage 2	-	-	5	5	-	-
Critical Hdwy	-	-	6.42	6.52	4.15	-
Critical Hdwy Stg 1	-	-	-	-	-	-
Critical Hdwy Stg 2	-	-	5.42	5.52	-	-
Follow-up Hdwy	-	-	3.518	4.018	2.245	-
Pot Cap-1 Maneuver	-	0	1017	560	1597	-
Stage 1	-	0	-	-	-	-
Stage 2	-	0	1018	892	-	-
Platoon blocked, %	-					-
Mov Cap-1 Maneuver	-	-	901	0	1597	-
Mov Cap-2 Maneuver	-	-	901	0	-	-
Stage 1	-	-	-	0	-	-
Stage 2	-	-	1018	0	-	-

Approach	EB	WB	NB
HCM Control Delay, s		9.1	
HCM LOS		A	

Minor Lane/Major Mvmt	NBL	NBR	EBT	WBLn1
Capacity (veh/h)	1597	-	-	901
HCM Lane V/C Ratio	0.114	-	-	0.014
HCM Control Delay (s)	7.5	-	-	9.1
HCM Lane LOS	A	-	-	A
HCM 95th %tile Q(veh)	0	-	-	0

Intersection	
Int Delay, s/veh	1.6

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Vol, veh/h	6	115	15	4	66	20
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Stop	Stop	Free	Free
RT Channelized	-	Free	-	None	-	Yield
Storage Length	-	0	-	-	0	0
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	77	77	77	77	77	77
Heavy Vehicles, %	8	8	47	47	8	8
Mvmt Flow	8	149	19	5	86	26

Major/Minor	Major1		Minor2		Major2	
Conflicting Flow All	0	-	8	179	8	-
Stage 1	-	-	0	171	-	-
Stage 2	-	-	8	8	-	-
Critical Hdwy	-	-	6.87	6.97	4.18	-
Critical Hdwy Stg 1	-	-	-	-	-	-
Critical Hdwy Stg 2	-	-	5.87	5.97	-	-
Follow-up Hdwy	-	-	3.923	4.423	2.272	-
Pot Cap-1 Maneuver	-	0	908	641	1574	-
Stage 1	-	0	-	-	-	-
Stage 2	-	0	910	807	-	-
Platoon blocked, %	-					-
Mov Cap-1 Maneuver	-	-	858	0	1574	-
Mov Cap-2 Maneuver	-	-	858	0	-	-
Stage 1	-	-	-	0	-	-
Stage 2	-	-	910	0	-	-

Approach	EB	WB	NB
HCM Control Delay, s		9.3	
HCM LOS		A	

Minor Lane/Major Mvmt	NBL	NBR	EBT	WBLn1
Capacity (veh/h)	1574	-	-	858
HCM Lane V/C Ratio	0.054	-	-	0.029
HCM Control Delay (s)	7.4	-	-	9.3
HCM Lane LOS	A	-	-	A
HCM 95th %tile Q(veh)	0	-	-	0

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	Cosgrove NB
Agency or Company	Atkins	Junction	7010 - Off to I-26 EB
Date Performed	3/20/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2013

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Number of Lanes, N	3	Downstream Adj Ramp	
☐ Yes	☐ On	Acceleration Lane Length, L_A		☐ Yes	☐ On
☑ No	☐ Off	Deceleration Lane Length L_D	125	☑ No	☐ Off
L_{up} =	ft	Freeway Volume, V_F	2492	L_{down} =	ft
V_u =	veh/h	Ramp Volume, V_R	816	V_D =	veh/h
		Freeway Free-Flow Speed, S_{FF}	55.0		
		Ramp Free-Flow Speed, S_{FR}	45.0		

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	2492	0.90	Level	11	0	0.948	1.00	2921
Ramp	816	0.90	Level	14	0	0.935	1.00	970
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 0.642 using Equation (Exhibit 13-7)

V_{12} = 2223 pc/h

V_3 or V_{av34} 698 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	2921	Exhibit 13-8	6750	No
$V_{FO} = V_F - V_R$	1951	Exhibit 13-8	6750	No
V_R	970	Exhibit 13-10	2100	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	2223	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = 22.2 (pc/mi/ln)

LOS = C (Exhibit 13-2)

Speed Determination

D_s = 0.385 (Exhibit 13-12)

S_R= 50.0 mph (Exhibit 13-12)

S_0= 60.3 mph (Exhibit 13-12)

S = 52.1 mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	Cosgrove NB
Agency or Company	Atkins	Junction	7010 - Off to I-26 EB
Date Performed	3/20/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2013

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Number of Lanes, N	3	Downstream Adj Ramp	
☐ Yes	☐ On	Acceleration Lane Length, L_A		☐ Yes	☐ On
☑ No	☐ Off	Deceleration Lane Length L_D	125	☑ No	☐ Off
L_{up} =	ft	Freeway Volume, V_F	1876	L_{down} =	ft
V_u =	veh/h	Ramp Volume, V_R	434	V_D =	veh/h
		Freeway Free-Flow Speed, S_{FF}	55.0		
		Ramp Free-Flow Speed, S_{FR}	45.0		

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	1876	0.90	Level	9	0	0.957	1.00	2178
Ramp	434	0.90	Level	10	0	0.952	1.00	506
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 0.682 using Equation (Exhibit 13-7)

V_{12} = 1647 pc/h

V_3 or V_{av34} 531 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	2178	Exhibit 13-8	6750	No
$V_{FO} = V_F - V_R$	1672	Exhibit 13-8	6750	No
V_R	506	Exhibit 13-10	2100	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	1647	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = 17.3 (pc/mi/ln)

LOS = B (Exhibit 13-2)

Speed Determination

D_s = 0.344 (Exhibit 13-12)

S_R= 50.5 mph (Exhibit 13-12)

S_0= 60.3 mph (Exhibit 13-12)

S = 52.6 mph (Exhibit 13-13)

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Navy Base ICTF

FREEWAY WEAVING WORKSHEET

General Information

Analyst	AJR
Agency/Company	Atkins
Date Performed	3/20/2014
Analysis Time Period	AM Peak

Site Information

Freeway/Dir of Travel	Cosgrove NB
Weaving Segment Location	7020-I-26 EB On to I-26 WB Off
Analysis Year	2013

Project Description *Navy Base ICTF*

Inputs

Weaving configuration	One-Sided
Weaving number of lanes, N	4
Weaving segment length, L_S	450ft
Freeway free-flow speed, FFS	45 mph
Segment type	C-D Roadway/ Multilane Highways
Freeway minimum speed, S_{MIN}	15
Freeway maximum capacity, C_{IFL}	2250
Terrain type	Level

Conversions to pc/h Under Base Conditions

	V (veh/h)	PHF	Truck (%)	RV (%)	E_T	E_R	f_{HV}	f_p	v (pc/h)
V_{FF}	859	0.90	2	0	1.5	1.2	0.990	1.00	964
V_{RF}	266	0.90	10	0	1.5	1.2	0.952	1.00	310
V_{FR}	817	0.90	19	0	1.5	1.2	0.913	1.00	994
V_{RR}	0	0.90	0	0	1.5	1.2	1.000	1.00	0
V_{NW}	964							V =	2268
V_W	1304								
VR	0.575								

Configuration Characteristics

Minimum maneuver lanes, N_{WL}	2 lc	Minimum weaving lane changes, LC_{MIN}	1304 lc/h
Interchange density, ID	0.2 int/mi	Weaving lane changes, LC_W	1392 lc/h
Minimum RF lane changes, LC_{RF}	1 lc/pc	Non-weaving lane changes, LC_{NW}	0 lc/h
Minimum FR lane changes, LC_{FR}	1 lc/pc	Total lane changes, LC_{ALL}	1392 lc/h
Minimum RR lane changes, LC_{RR}	lc/pc	Non-weaving vehicle index, I_{NW}	9

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment flow rate, v	2268 pc/h	Weaving intensity factor, W	0.551
Weaving segment capacity, c_w	4133 veh/h	Weaving segment speed, S	33.7 mph
Weaving segment v/c ratio	0.543	Average weaving speed, S_W	34.3 mph
Weaving segment density, D	16.8 pc/mi/ln	Average non-weaving speed, S_{NW}	32.9 mph
Level of Service, LOS	B	Maximum weaving length, L_{MAX}	8716 ft

Notes

a. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments".
b. For volumes that exceed the weaving segment capacity, the level of service is "F".

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Navy Base ICTF

FREEWAY WEAVING WORKSHEET

General Information

Analyst	AJR
Agency/Company	Atkins
Date Performed	3/20/2014
Analysis Time Period	PM Peak

Site Information

Freeway/Dir of Travel	Cosgrove NB
Weaving Segment Location	7020-I-26 EB On to I-26 WB Off
Analysis Year	2013

Project Description *Navy Base ICTF*

Inputs

Weaving configuration	One-Sided
Weaving number of lanes, N	4
Weaving segment length, L_S	450ft
Freeway free-flow speed, FFS	45 mph
Segment type	C-D Roadway/ Multilane Highways
Freeway minimum speed, S_{MIN}	15
Freeway maximum capacity, C_{IFL}	2250
Terrain type	Level

Conversions to pc/h Under Base Conditions

	V (veh/h)	PHF	Truck (%)	RV (%)	E_T	E_R	f_{HV}	f_p	v (pc/h)
V_{FF}	697	0.90	2	0	1.5	1.2	0.990	1.00	782
V_{RF}	132	0.90	13	0	1.5	1.2	0.939	1.00	156
V_{FR}	745	0.90	19	0	1.5	1.2	0.913	1.00	906
V_{RR}	0	0.90	0	0	1.5	1.2	1.000	1.00	0
V_{NW}	782							V =	1844
V_W	1062								
VR	0.576								

Configuration Characteristics

Minimum maneuver lanes, N_{WL}	2 lc	Minimum weaving lane changes, LC_{MIN}	1062 lc/h
Interchange density, ID	0.2 int/mi	Weaving lane changes, LC_W	1150 lc/h
Minimum RF lane changes, LC_{RF}	1 lc/pc	Non-weaving lane changes, LC_{NW}	0 lc/h
Minimum FR lane changes, LC_{FR}	1 lc/pc	Total lane changes, LC_{ALL}	1150 lc/h
Minimum RR lane changes, LC_{RR}	lc/pc	Non-weaving vehicle index, I_{NW}	7

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment flow rate, v	1844 pc/h	Weaving intensity factor, W	0.474
Weaving segment capacity, c_w	4126 veh/h	Weaving segment speed, S	35.3 mph
Weaving segment v/c ratio	0.442	Average weaving speed, S_W	35.4 mph
Weaving segment density, D	13.1 pc/mi/ln	Average non-weaving speed, S_{NW}	35.1 mph
Level of Service, LOS	B	Maximum weaving length, L_{MAX}	8727 ft

Notes

a. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments".
b. For volumes that exceed the weaving segment capacity, the level of service is "F".

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	Cosgrove NB
Agency or Company	Atkins	Junction	7030 - NB On from I-26 WB
Date Performed	4/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2013

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Number of Lanes, N: 3	☐ Yes ☐ On
☑ No ☐ Off	Acceleration Lane Length, L_A: 200	☑ No ☐ Off
L_{up} = ft	Deceleration Lane Length L_D:	L_{down} = ft
V_u = veh/h	Freeway Volume, V_F: 1125	V_D = veh/h
	Ramp Volume, V_R: 342	
	Freeway Free-Flow Speed, S_{FF}: 55.0	
	Ramp Free-Flow Speed, S_{FR}: 45.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	1125	0.90	Level	2	0	0.990	1.00	1263
Ramp	342	0.90	Level	4	0	0.980	1.00	388
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 0.583 using Equation (Exhibit 13-6)

V_{12} = 736 pc/h

V_3 or V_{av34} 527 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	1651	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	1124	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = 12.8 (pc/mi/ln)

LOS = B (Exhibit 13-2)

Speed Determination

M_S = 0.315 (Exibit 13-11)

S_R= 50.9 mph (Exhibit 13-11)

S_0= 54.9 mph (Exhibit 13-11)

S = 52.1 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	Cosgrove NB
Agency or Company	Atkins	Junction	7030 - NB On from I-26 WB
Date Performed	4/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2013

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Number of Lanes, N: 3	☐ Yes ☐ On
☑ No ☐ Off	Acceleration Lane Length, L_A: 200	☑ No ☐ Off
L_{up} = ft	Deceleration Lane Length L_D:	L_{down} = ft
V_u = veh/h	Freeway Volume, V_F: 829	V_D = veh/h
	Ramp Volume, V_R: 312	
	Freeway Free-Flow Speed, S_{FF}: 55.0	
	Ramp Free-Flow Speed, S_{FR}: 45.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	829	0.90	Level	2	0	0.990	1.00	930
Ramp	312	0.90	Level	7	0	0.966	1.00	359
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 0.583 using Equation (Exhibit 13-6)

V_{12} = 542 pc/h

V_3 or V_{av34} 388 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	1289	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	901	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = 11.1 (pc/mi/ln)

LOS = B (Exhibit 13-2)

Speed Determination

M_S = 0.313 (Exibit 13-11)

S_R= 50.9 mph (Exhibit 13-11)

S_0= 55.0 mph (Exhibit 13-11)

S = 52.1 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	Cosgrove SB
Agency or Company	Atkins	Junction	7040 - Off to I-26 WB
Date Performed	3/20/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2013

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Number of Lanes, N	2	Downstream Adj Ramp	
☐ Yes	☐ On	Acceleration Lane Length, L_A		☐ Yes	☐ On
☑ No	☐ Off	Deceleration Lane Length L_D	225	☑ No	☐ Off
L_{up} =	ft	Freeway Volume, V_F	836	L_{down} =	ft
V_u =	veh/h	Ramp Volume, V_R	140	V_D =	veh/h
		Freeway Free-Flow Speed, S_{FF}	55.0		
		Ramp Free-Flow Speed, S_{FR}	45.0		

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	836	0.90	Level	7	0	0.966	1.00	961
Ramp	140	0.90	Level	21	0	0.905	1.00	172
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 1.000 using Equation (Exhibit 13-7)

V_{12} = 961 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	961	Exhibit 13-8	4500	No
$V_{FO} = V_F - V_R$	789	Exhibit 13-8	4500	No
V_R	172	Exhibit 13-10	2100	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	961	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = 10.5 (pc/mi/ln)

LOS = B (Exhibit 13-2)

Speed Determination

D_s = 0.313 (Exhibit 13-12)

S_R= 50.9 mph (Exhibit 13-12)

S_0= N/A mph (Exhibit 13-12)

S = 50.9 mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	Cosgrove SB
Agency or Company	Atkins	Junction	7040 - Off to I-26 WB
Date Performed	3/20/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2013

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Number of Lanes, N: 2	☐ Yes ☐ On
☑ No ☐ Off	Acceleration Lane Length, L_A	☑ No ☐ Off
L_{up} = ft	Deceleration Lane Length L_D: 225	L_{down} = ft
V_u = veh/h	Freeway Volume, V_F: 1644	V_D = veh/h
	Ramp Volume, V_R: 294	
	Freeway Free-Flow Speed, S_{FF}: 55.0	
	Ramp Free-Flow Speed, S_{FR}: 45.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	1644	0.90	Level	3	0	0.985	1.00	1854
Ramp	294	0.90	Level	10	0	0.952	1.00	343
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 1.000 using Equation (Exhibit 13-7)

V_{12} = 1854 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	1854	Exhibit 13-8	4500	No
$V_{FO} = V_F - V_R$	1511	Exhibit 13-8	4500	No
V_R	343	Exhibit 13-10	2100	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	1854	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = 18.2 (pc/mi/ln)

LOS = B (Exhibit 13-2)

Speed Determination

D_s = 0.329 (Exhibit 13-12)

S_R= 50.7 mph (Exhibit 13-12)

S_0= N/A mph (Exhibit 13-12)

S = 50.7 mph (Exhibit 13-13)

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Navy Base ICTF

FREEWAY WEAVING WORKSHEET

General Information

Analyst	AJR
Agency/Company	Atkins
Date Performed	3/20/2014
Analysis Time Period	AM Peak

Site Information

Freeway/Dir of Travel	Cosgrove SB
Weaving Segment Location	7050-I-26 WB On to I-26 EB Off
Analysis Year	2013

Project Description *Navy Base ICTF*

Inputs

Weaving configuration	One-Sided
Weaving number of lanes, N	3
Weaving segment length, L_S	475ft
Freeway free-flow speed, FFS	45 mph
Segment type	C-D Roadway/ Multilane Highways
Freeway minimum speed, S_{MIN}	15
Freeway maximum capacity, C_{IFL}	2250
Terrain type	Level

Conversions to pc/h Under Base Conditions

	V (veh/h)	PHF	Truck (%)	RV (%)	E_T	E_R	f_{HV}	f_p	v (pc/h)
V_{FF}	351	0.90	2	0	1.5	1.2	0.990	1.00	394
V_{RF}	348	0.90	14	0	1.5	1.2	0.935	1.00	414
V_{FR}	345	0.90	11	0	1.5	1.2	0.948	1.00	404
V_{RR}	0	0.90	0	0	1.5	1.2	1.000	1.00	0
V_{NW}	394							V =	1212
V_W	818								
VR	0.675								

Configuration Characteristics

Minimum maneuver lanes, N_{WL}	2 lc	Minimum weaving lane changes, LC_{MIN}	818 lc/h
Interchange density, ID	0.2 int/mi	Weaving lane changes, LC_W	872 lc/h
Minimum RF lane changes, LC_{RF}	1 lc/pc	Non-weaving lane changes, LC_{NW}	0 lc/h
Minimum FR lane changes, LC_{FR}	1 lc/pc	Total lane changes, LC_{ALL}	872 lc/h
Minimum RR lane changes, LC_{RR}	lc/pc	Non-weaving vehicle index, I_{NW}	4

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment flow rate, v	1212 pc/h	Weaving intensity factor, W	0.365
Weaving segment capacity, c_w	3521 veh/h	Weaving segment speed, S	37.0 mph
Weaving segment v/c ratio	0.341	Average weaving speed, S_W	37.0 mph
Weaving segment density, D	10.9 pc/mi/ln	Average non-weaving speed, S_{NW}	37.2 mph
Level of Service, LOS	A	Maximum weaving length, L_{MAX}	9942 ft

Notes

a. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments".
b. For volumes that exceed the weaving segment capacity, the level of service is "F".

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Navy Base ICTF

FREEWAY WEAVING WORKSHEET

General Information

Analyst	AJR
Agency/Company	Atkins
Date Performed	3/20/2014
Analysis Time Period	PM Peak

Site Information

Freeway/Dir of Travel	Cosgrove SB
Weaving Segment Location	7050-I-26 WB On to I-26 EB Off
Analysis Year	2013

Project Description *Navy Base ICTF*

Inputs

Weaving configuration	One-Sided
Weaving number of lanes, N	3
Weaving segment length, L_S	475ft
Freeway free-flow speed, FFS	45 mph
Segment type	C-D Roadway/ Multilane Highways
Freeway minimum speed, S_{MIN}	15
Freeway maximum capacity, C_{IFL}	2250
Terrain type	Level

Conversions to pc/h Under Base Conditions

	V (veh/h)	PHF	Truck (%)	RV (%)	E_T	E_R	f_{HV}	f_p	v (pc/h)
V_{FF}	1007	0.90	2	0	1.5	1.2	0.990	1.00	1130
V_{RF}	809	0.90	12	0	1.5	1.2	0.943	1.00	953
V_{FR}	343	0.90	3	0	1.5	1.2	0.985	1.00	387
V_{RR}	0	0.90	0	0	1.5	1.2	1.000	1.00	0
V_{NW}	1130							V =	2470
V_W	1340								
VR	0.543								

Configuration Characteristics

Minimum maneuver lanes, N_{WL}	2 lc	Minimum weaving lane changes, LC_{MIN}	1340 lc/h
Interchange density, ID	0.2 int/mi	Weaving lane changes, LC_W	1394 lc/h
Minimum RF lane changes, LC_{RF}	1 lc/pc	Non-weaving lane changes, LC_{NW}	0 lc/h
Minimum FR lane changes, LC_{FR}	1 lc/pc	Total lane changes, LC_{ALL}	1394 lc/h
Minimum RR lane changes, LC_{RR}	lc/pc	Non-weaving vehicle index, I_{NW}	11

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment flow rate, v	2470 pc/h	Weaving intensity factor, W	0.528
Weaving segment capacity, c_w	4380 veh/h	Weaving segment speed, S	33.1 mph
Weaving segment v/c ratio	0.558	Average weaving speed, S_W	34.6 mph
Weaving segment density, D	24.9 pc/mi/ln	Average non-weaving speed, S_{NW}	31.4 mph
Level of Service, LOS	C	Maximum weaving length, L_{MAX}	8328 ft

Notes

a. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments".
b. For volumes that exceed the weaving segment capacity, the level of service is "F".

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RAMP ADD OR DROP LANE ANALYSIS (MAINLINE <55 MPH)

ATKINS

General Information

Date Performed:	3/20/2014	Freeway/Direction	Cosgrove SB
Analysis Year	2013	Junction	From I-26 EB
Analysis Time Period:	AM Peak	Segment ID	7060
Project Description:	Navy Base ICTF		

Inputs

	Mainline Upstream Ramp	Mainline Downstream Ramp	Ramp
Number of Lanes, N	2	3	1
Free-Flow Speed, FFS (mph)	45	45	45
Volume, V (veh/h)	699	1,454	755
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	6%	8%	10%
%RVs, P_R	0%	0%	0%

Performance Measures

	Upstream of Off-Ramp	Downstream of Off-Ramp	Off-Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.97	0.96	0.95
Demand Flow Rate, v_p (pc/h/ln)	400	560	881
Capacity Flow Rate, c (pc/h/ln)	2,100	2,100	2,100
v/c ratio	0.19	0.27	0.42
Density, D_{MD} (pc/mi/ln)	7.0	9.8	15.4
LOS	A	A	B

Formulas and Reference Material

$$f_{HV} = \frac{1}{1+P_T(E_T-1)+P_R(E_R-1)}$$ HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P}$$ HCM 2010, Equation 11-2

$$D_{MD} = \frac{0.0175*v_f}{N}$$ HCM 2010, Equation 13-26

Ramp Roadways Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

Diverge LOS Thresholds

LOS	Density (pc/mi/ln)
A	≤10
B	>10-20
C	>20-28
D	>28-35
E	>35
F	v/c > 1

Source: HCM 2010, Exhibit 13-2

RAMP ADD OR DROP LANE ANALYSIS (MAINLINE <55 MPH)

ATKINS

General Information

Date Performed:	3/20/2014	Freeway/Direction	Cosgrove SB
Analysis Year	2013	Junction	From I-26 EB
Analysis Time Period:	PM Peak	Segment ID	7060
Project Description:	Navy Base ICTF		

Inputs

	Mainline Upstream Ramp	Mainline Downstream Ramp	Ramp
Number of Lanes, N	2	3	1
Free-Flow Speed, FFS (mph)	45	45	45
Volume, V (veh/h)	1,816	2,944	1,128
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	6%	7%	9%
%RVs, P_R	0%	0%	0%

Performance Measures

	Upstream of Off-Ramp	Downstream of Off-Ramp	Off-Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.97	0.97	0.96
Demand Flow Rate, v_p (pc/h/ln)	1,039	1,129	1,310
Capacity Flow Rate, c (pc/h/ln)	2,100	2,100	2,100
v/c ratio	0.49	0.54	0.62
Density, D_{MD} (pc/mi/ln)	18.2	19.8	22.9
LOS	B	B	C

Formulas and Reference Material

$$f_{HV} = \frac{1}{1+P_T(E_T-1)+P_R(E_R-1)}$$ HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P}$$ HCM 2010, Equation 11-2

$$D_{MD} = \frac{0.0175*v_f}{N}$$ HCM 2010, Equation 13-26

Ramp Roadways Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

Diverge LOS Thresholds

LOS	Density (pc/mi/ln)
A	≤10
B	>10-20
C	>20-28
D	>28-35
E	>35
F	v/c > 1

Source: HCM 2010, Exhibit 13-2

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	Montague NB
Agency or Company	Atkins	Junction	8010 - Off to I-26 EB
Date Performed	3/20/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2013

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Number of Lanes, N	2	Downstream Adj Ramp	
☐ Yes	☐ On	Acceleration Lane Length, L_A		☐ Yes	☐ On
☑ No	☐ Off	Deceleration Lane Length L_D	350	☑ No	☐ Off
L_{up} =	ft	Freeway Volume, V_F	1414	L_{down} =	ft
		Ramp Volume, V_R	442		
V_u =	veh/h	Freeway Free-Flow Speed, S_{FF}	55.0	V_D =	veh/h
		Ramp Free-Flow Speed, S_{FR}	45.0		

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	1414	0.90	Level	6	0	0.971	1.00	1618
Ramp	442	0.90	Level	7	0	0.966	1.00	508
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 1.000 using Equation (Exhibit 13-7)

V_{12} = 1618 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	1618	Exhibit 13-8	4500	No
$V_{FO} = V_F - V_R$	1110	Exhibit 13-8	4500	No
V_R	508	Exhibit 13-10	2100	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	1618	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = 15.0 (pc/mi/ln)

LOS = B (Exhibit 13-2)

Speed Determination

D_s = 0.344 (Exhibit 13-12)

S_R= 50.5 mph (Exhibit 13-12)

S_0= N/A mph (Exhibit 13-12)

S = 50.5 mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	Montague NB
Agency or Company	Atkins	Junction	8010 - Off to I-26 EB
Date Performed	3/20/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2013

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Number of Lanes, N	2	Downstream Adj Ramp	
☐ Yes	☐ On	Acceleration Lane Length, L_A		☐ Yes	☐ On
☑ No	☐ Off	Deceleration Lane Length L_D	350	☑ No	☐ Off
L_{up} =	ft	Freeway Volume, V_F	1563	L_{down} =	ft
		Ramp Volume, V_R	505		
V_u =	veh/h	Freeway Free-Flow Speed, S_{FF}	55.0	V_D =	veh/h
		Ramp Free-Flow Speed, S_{FR}	45.0		

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	1563	0.90	Level	2	0	0.990	1.00	1754
Ramp	505	0.90	Level	2	0	0.990	1.00	567
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 1.000 using Equation (Exhibit 13-7)

V_{12} = 1754 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	1754	Exhibit 13-8	4500	No
$V_{FO} = V_F - V_R$	1187	Exhibit 13-8	4500	No
V_R	567	Exhibit 13-10	2100	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	1754	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = 16.2 (pc/mi/ln)

LOS = B (Exhibit 13-2)

Speed Determination

D_s = 0.349 (Exhibit 13-12)

S_R= 50.5 mph (Exhibit 13-12)

S_0= N/A mph (Exhibit 13-12)

S = 50.5 mph (Exhibit 13-13)

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RAMP ADD OR DROP LANE ANALYSIS (MAINLINE <55 MPH)

ATKINS

General Information

Date Performed:	3/20/2014	Freeway/Direction	Montague NB
Analysis Year	2013	Junction	From I-26 EB
Analysis Time Period:	AM Peak	Segment ID	8020
Project Description:	Navy Base ICTF		

Inputs

	Mainline Upstream Ramp	Mainline Downstream Ramp	Ramp
Number of Lanes, N	2	3	1
Free-Flow Speed, FFS (mph)	45	45	25
Volume, V (veh/h)	972	1,395	423
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	6%	6%	6%
%RVs, P_R	0%	0%	0%

Performance Measures

	Upstream of Off-Ramp	Downstream of Off-Ramp	Off-Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.97	0.97	0.97
Demand Flow Rate, v_p (pc/h/ln)	556	532	484
Capacity Flow Rate, c (pc/h/ln)	2,100	2,100	1,900
v/c ratio	0.26	0.25	0.25
Density, D_{MD} (pc/mi/ln)	9.7	9.3	8.5
LOS	A	A	A

Formulas and Reference Material

$$f_{HV} = \frac{1}{1+P_T(E_T-1)+P_R(E_R-1)}$$ HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P}$$ HCM 2010, Equation 11-2

$$D_{MD} = \frac{0.0175*v_f}{N}$$ HCM 2010, Equation 13-26

Ramp Roadways Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

Diverge LOS Thresholds

LOS	Density (pc/mi/ln)
A	≤10
B	>10-20
C	>20-28
D	>28-35
E	>35
F	v/c > 1

Source: HCM 2010, Exhibit 13-2

RAMP ADD OR DROP LANE ANALYSIS (MAINLINE <55 MPH)

ATKINS

General Information

Date Performed:	3/20/2014	Freeway/Direction	Montague NB
Analysis Year	2013	Junction	From I-26 EB
Analysis Time Period:	PM Peak	Segment ID	8020
Project Description:	Navy Base ICTF		

Inputs

	Mainline Upstream Ramp	Mainline Downstream Ramp	Ramp
Number of Lanes, N	2	3	1
Free-Flow Speed, FFS (mph)	45	45	25
Volume, V (veh/h)	1,058	1,272	214
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	3%	3%	4%
%RVs, P_R	0%	0%	0%

Performance Measures

	Upstream of Off-Ramp	Downstream of Off-Ramp	Off-Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.99	0.99	0.98
Demand Flow Rate, v_p (pc/h/ln)	597	478	243
Capacity Flow Rate, c (pc/h/ln)	2,100	2,100	1,900
v/c ratio	0.28	0.23	0.13
Density, D_{MD} (pc/mi/ln)	10.4	8.4	4.3
LOS	B	A	A

Formulas and Reference Material

$$f_{HV} = \frac{1}{1+P_T(E_T-1)+P_R(E_R-1)}$$ HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P}$$ HCM 2010, Equation 11-2

$$D_{MD} = \frac{0.0175*v_f}{N}$$ HCM 2010, Equation 13-26

Ramp Roadways Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

Diverge LOS Thresholds

LOS	Density (pc/mi/ln)
A	≤10
B	>10-20
C	>20-28
D	>28-35
E	>35
F	v/c > 1

Source: HCM 2010, Exhibit 13-2

RAMP ADD OR DROP LANE ANALYSIS (MAINLINE <55 MPH)

ATKINS

General Information

Date Performed:	3/20/2014	Freeway/Direction	Montague SB
Analysis Year	2013	Junction	Off to I-26 EB
Analysis Time Period:	AM Peak	Segment ID	8030
Project Description:	Navy Base ICTF		

Inputs

	Mainline Upstream Ramp	Mainline Downstream Ramp	Ramp
Number of Lanes, N	3	2	1
Free-Flow Speed, FFS (mph)	45	45	25
Volume, V (veh/h)	1,068	786	282
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	8%	8%	10%
%RVs, P_R	0%	0%	0%

Performance Measures

	Upstream of Off-Ramp	Downstream of Off-Ramp	Off-Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.96	0.96	0.95
Demand Flow Rate, v_p (pc/h/ln)	411	454	329
Capacity Flow Rate, c (pc/h/ln)	2,100	2,100	1,900
v/c ratio	0.20	0.22	0.17
Density, D_{MD} (pc/mi/ln)	7.2	7.9	5.8
LOS	A	A	A

Formulas and Reference Material

$$f_{HV} = \frac{1}{1+P_T(E_T-1)+P_R(E_R-1)}$$ HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P}$$ HCM 2010, Equation 11-2

$$D_{MD} = \frac{0.0175*v_f}{N}$$ HCM 2010, Equation 13-26

Ramp Roadways Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

Diverge LOS Thresholds

LOS	Density (pc/mi/ln)
A	≤10
B	>10-20
C	>20-28
D	>28-35
E	>35
F	v/c > 1

Source: HCM 2010, Exhibit 13-2

RAMP ADD OR DROP LANE ANALYSIS (MAINLINE <55 MPH)

ATKINS

General Information

Date Performed:	3/20/2014	Freeway/Direction	Montague SB
Analysis Year	2013	Junction	Off to I-26 EB
Analysis Time Period:	PM Peak	Segment ID	8030
Project Description:	Navy Base ICTF		

Inputs

	Mainline Upstream Ramp	Mainline Downstream Ramp	Ramp
Number of Lanes, N	3	2	1
Free-Flow Speed, FFS (mph)	45	45	25
Volume, V (veh/h)	1,510	1,156	354
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	2%	2%	4%
%RVs, P_R	0%	0%	0%

Performance Measures

	Upstream of Off-Ramp	Downstream of Off-Ramp	Off-Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.99	0.99	0.98
Demand Flow Rate, v_p (pc/h/ln)	565	649	401
Capacity Flow Rate, c (pc/h/ln)	2,100	2,100	1,900
v/c ratio	0.27	0.31	0.21
Density, D_{MD} (pc/mi/ln)	9.9	11.4	7.0
LOS	A	B	A

Formulas and Reference Material

$$f_{HV} = \frac{1}{1+P_T(E_T-1)+P_R(E_R-1)}$$ HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P}$$ HCM 2010, Equation 11-2

$$D_{MD} = \frac{0.0175*v_f}{N}$$ HCM 2010, Equation 13-26

Ramp Roadways Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

Diverge LOS Thresholds

LOS	Density (pc/mi/ln)
A	≤10
B	>10-20
C	>20-28
D	>28-35
E	>35
F	v/c > 1

Source: HCM 2010, Exhibit 13-2

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	Montague SB
Agency or Company	Atkins	Junction	8040 - On from I-26 EB
Date Performed	4/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2013

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Number of Lanes, N: 2	☐ Yes ☐ On
☑ No ☐ Off	Acceleration Lane Length, L_A: 550	☑ No ☐ Off
L_{up} = ft	Deceleration Lane Length L_D:	L_{down} = ft
V_u = veh/h	Freeway Volume, V_F: 786	V_D = veh/h
	Ramp Volume, V_R: 337	
	Freeway Free-Flow Speed, S_{FF}: 55.0	
	Ramp Free-Flow Speed, S_{FR}: 45.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	786	0.90	Level	8	0	0.962	1.00	908
Ramp	337	0.90	Level	12	0	0.943	1.00	397
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 1.000 using Equation (Exhibit 13-6)

V_{12} = 908 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	1305	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	1305	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = 12.0 (pc/mi/ln)

LOS = B (Exhibit 13-2)

Speed Determination

M_S = 0.286 (Exibit 13-11)

S_R= 51.3 mph (Exhibit 13-11)

S_0= N/A mph (Exhibit 13-11)

S = 51.3 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	Montague SB
Agency or Company	Atkins	Junction	8040 - On from I-26 EB
Date Performed	4/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2013

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Number of Lanes, N: 2	☐ Yes ☐ On
☑ No ☐ Off	Acceleration Lane Length, L_A: 550	☑ No ☐ Off
L_{up} = ft	Deceleration Lane Length L_D:	L_{down} = ft
V_u = veh/h	Freeway Volume, V_F: 1156	V_D = veh/h
	Ramp Volume, V_R: 197	
	Freeway Free-Flow Speed, S_{FF}: 55.0	
	Ramp Free-Flow Speed, S_{FR}: 45.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	1156	0.90	Level	2	0	0.990	1.00	1297
Ramp	197	0.90	Level	11	0	0.948	1.00	231
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 1.000 using Equation (Exhibit 13-6)

V_{12} = 1297 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	1528	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	1528	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = 13.8 (pc/mi/ln)

LOS = B (Exhibit 13-2)

Speed Determination

M_S = 0.289 (Exibit 13-11)

S_R= 51.2 mph (Exhibit 13-11)

S_0= N/A mph (Exhibit 13-11)

S = 51.2 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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Appendix E
Traffic Analysis Worksheets

2018 Opening Year

No Action Alternative

Appendix E
Traffic Analysis Worksheets

2018 Opening Year

No Action Alternative

Interstate 26

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-26 EB
Agency or Company	Atkins	Junction	1010-EB Off to C-D
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2018 No-Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Freeway Number of Lanes, N	4	Downstream Adj Ramp	
☐ Yes	☐ On	Ramp Number of Lanes, N	1	☐ Yes	☐ On
☑ No	☐ Off	Acceleration Lane Length, L_A		☑ No	☐ Off
L_{up} =	ft	Deceleration Lane Length L_D	400	L_{down} =	ft
V_u =	veh/h	Freeway Volume, V_F	8362	V_D =	veh/h
		Ramp Volume, V_R	989		
		Freeway Free-Flow Speed, S_{FF}	60.0		
		Ramp Free-Flow Speed, S_{FR}	55.0		

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	8362	0.90	Level	15	0	0.930	1.00	9988
Ramp	989	0.90	Level	6	0	0.971	1.00	1132
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 0.436 using Equation (Exhibit 13-7)

V_{12} = 4993 pc/h

V_3 or V_{av34} 2497 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	9988	Exhibit 13-8	9200	Yes
$V_{FO} = V_F - V_R$	8856	Exhibit 13-8	9200	No
V_R	1132	Exhibit 13-10	2200	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	4993	Exhibit 13-8	4400:All	Yes

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = 43.6 (pc/mi/ln)

LOS = F (Exhibit 13-2)

Speed Determination

D_s = 0.270 (Exhibit 13-12)

S_R= 55.1 mph (Exhibit 13-12)

S_0= 60.0 mph (Exhibit 13-12)

S = 57.5 mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-26 EB
Agency or Company	Atkins	Junction	1010-EB Off to C-D
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2018 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp
☐ Yes ☐ On
☑ No ☐ Off
L_{up} = ft
V_u = veh/h

Freeway Number of Lanes, N	4
Ramp Number of Lanes, N	1
Acceleration Lane Length, L_A	
Deceleration Lane Length L_D	400
Freeway Volume, V_F	5653
Ramp Volume, V_R	544
Freeway Free-Flow Speed, S_{FF}	60.0
Ramp Free-Flow Speed, S_{FR}	55.0

Downstream Adj Ramp
☐ Yes ☐ On
☑ No ☐ Off
L_{down} = ft
V_D = veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	5653	0.90	Level	11	0	0.948	1.00	6627
Ramp	544	0.90	Level	9	0	0.957	1.00	632
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)
P_{FM} = using Equation (Exhibit 13-6)
V_{12} = pc/h
V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)
Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No
Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No
If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = (pc/mi/ln)
LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)
S_R= mph (Exhibit 13-11)
S_0= mph (Exhibit 13-11)
S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)
P_{FD} = 0.436 using Equation (Exhibit 13-7)
V_{12} = 3246 pc/h
V_3 or V_{av34} 1690 pc/h (Equation 13-14 or 13-17)
Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No
Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No
If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	6627	Exhibit 13-8	9200	No
$V_{FO} = V_F - V_R$	5995	Exhibit 13-8	9200	No
V_R	632	Exhibit 13-10	2200	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	3246	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = 28.6 (pc/mi/ln)
LOS = D (Exhibit 13-2)

Speed Determination

D_s = 0.225 (Exhibit 13-12)
S_R= 56.0 mph (Exhibit 13-12)
S_0= 63.1 mph (Exhibit 13-12)
S = 59.4 mph (Exhibit 13-13)

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-26 EB*
Agency or Company	*Atkins*	From/To	*1015-Avai/Rem CD Off to CD On*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2018 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*7373*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*15*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.930*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*4*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*60.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*60.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*2202*	pc/h/ln
S	*53.4*	mph
D = v_p / S	*41.2*	pc/mi/ln
LOS	*E*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-26 EB*
Agency or Company	*Atkins*	From/To	*1015-Avai/Rem CD Off to CD On*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*PM Peak*	Analysis Year	*2018 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*5109*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*12*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.943*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*4*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*60.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*60.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1504*	pc/h/ln
S	*60.0*	mph
D = v_p / S	*25.1*	pc/mi/ln
LOS	*C*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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RAMP ADD OR DROP LANE ANALYSIS (MAINLINE <55 MPH)

ATKINS

General Information

Date Performed:	7/25/2014	Freeway/Direction	I-26 EB C-D
Analysis Year	2018 No Action	Junction	EB Off to Aviation Ave
Analysis Time Period:	AM Peak	Segment ID	1020
Project Description:	Navy Base ICTF		

Inputs

	Mainline Upstream Ramp	Mainline Downstream Ramp	Ramp
Number of Lanes, N	1	1	1
Free-Flow Speed, FFS (mph)	55	55	45
Volume, V (veh/h)	989	537	452
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	6%	7%	5%
%RVs, P_R	0%	0%	0%

Performance Measures

	Upstream of Off-Ramp	Downstream of Off-Ramp	Off-Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.97	0.97	0.98
Demand Flow Rate, v_p (pc/h/ln)	1,132	618	515
Capacity Flow Rate, c (pc/h/ln)	2,200	2,200	2,100
v/c ratio	0.51	0.28	0.25
Density, D_{MD} (pc/mi/ln)	19.8	10.8	9.0
LOS	B	B	A

Formulas and Reference Material

$$f_{HV} = \frac{1}{1+P_T(E_T-1)+P_R(E_R-1)}$$ HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P}$$ HCM 2010, Equation 11-2

$$D_{MD} = \frac{0.0175*v_f}{N}$$ HCM 2010, Equation 13-26

Ramp Roadways Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

Diverge LOS Thresholds

LOS	Density (pc/mi/ln)
A	≤10
B	>10-20
C	>20-28
D	>28-35
E	>35
F	v/c > 1

Source: HCM 2010, Exhibit 13-2

RAMP ADD OR DROP LANE ANALYSIS (MAINLINE <55 MPH)

ATKINS

General Information

Date Performed:	7/25/2014	Freeway/Direction	I-26 EB C-D
Analysis Year	2018 No-Action	Junction	EB Off to Aviation Ave
Analysis Time Period:	PM Peak	Segment ID	1020
Project Description:	Navy Base ICTF		

Inputs

	Mainline Upstream Ramp	Mainline Downstream Ramp	Ramp
Number of Lanes, N	1	1	1
Free-Flow Speed, FFS (mph)	55	55	45
Volume, V (veh/h)	544	352	192
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	9%	9%	10%
%RVs, P_R	0%	0%	0%

Performance Measures

	Upstream of Off-Ramp	Downstream of Off-Ramp	Off-Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.96	0.96	0.95
Demand Flow Rate, v_p (pc/h/ln)	632	409	224
Capacity Flow Rate, c (pc/h/ln)	2,200	2,200	2,100
v/c ratio	0.29	0.19	0.11
Density, D_{MD} (pc/mi/ln)	11.1	7.2	3.9
LOS	B	A	A

Formulas and Reference Material

$$f_{HV} = \frac{1}{1+P_T(E_T-1)+P_R(E_R-1)}$$ HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P}$$ HCM 2010, Equation 11-2

$$D_{MD} = \frac{0.0175*v_f}{N}$$ HCM 2010, Equation 13-26

Ramp Roadways Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

Diverge LOS Thresholds

LOS	Density (pc/mi/ln)
A	≤10
B	>10-20
C	>20-28
D	>28-35
E	>35
F	v/c > 1

Source: HCM 2010, Exhibit 13-2

BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-26 EB C-D*
Agency or Company	*Atkins*	From/To	*1025 - Avia Off to Avia WB On*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2018 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*1074*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*7*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.966*

Speed Inputs			Calc Speed Adj and FFS		
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f_{LW}		mph
Number of Lanes, N	*2*		f_{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	*55.0*	mph	FFS	*55.0*	mph
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures			Design (N)	
Operational (LOS)			Design (N)	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*618*	pc/h/ln	Design LOS	
			v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h/ln
S	*55.0*	mph	S	mph
D = v_p / S	*11.2*	pc/mi/ln	D = v_p / S	pc/mi/ln
LOS	*B*		Required Number of Lanes, N	

Glossary		Factor Location	
N - Number of lanes	S - Speed	E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
V - Hourly volume	D - Density	E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 11-18	TRD - Page 11-11
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 11-2, 11-3	
DDHV - Directional design hour volume			

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-26 EB C-D*
Agency or Company	*Atkins*	From/To	*1025 - Avia Off to Avia WB On*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*PM Peak*	Analysis Year	*2018 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*704*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*9*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.957*

Speed Inputs			Calc Speed Adj and FFS		
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f_{LW}		mph
Number of Lanes, N	*2*		f_{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	*55.0*	mph	FFS	*55.0*	mph
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures			Design (N)	
Operational (LOS)			Design (N)	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*409*	pc/h/ln	Design LOS	
			v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h/ln
S	*55.0*	mph	S	mph
D = v_p / S	*7.4*	pc/mi/ln	D = v_p / S	pc/mi/ln
LOS	*A*		Required Number of Lanes, N	

Glossary		Factor Location	
N - Number of lanes	S - Speed	E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
V - Hourly volume	D - Density	E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 11-18	TRD - Page 11-11
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 11-2, 11-3	
DDHV - Directional design hour volume			

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F-2648

RAMP ADD OR DROP LANE ANALYSIS (MAINLINE <55 MPH)

ATKINS

General Information

Date Performed:	7/25/2014	Freeway/Direction	I-26 EB C-D
Analysis Year	2018 No Action	Junction	WB Aviation EB On Loop
Analysis Time Period:	AM Peak	Segment ID	1030
Project Description:	Navy Base ICTF		

Inputs

	Mainline Upstream Ramp	Mainline Downstream Ramp	Ramp
Number of Lanes, N	1	1	1
Free-Flow Speed, FFS (mph)	55	55	25
Volume, V (veh/h)	537	833	296
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	7%	6%	3%
%RVs, P_R	0%	0%	0%

Performance Measures

	Upstream of Off-Ramp	Downstream of Off-Ramp	Off-Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.97	0.97	0.99
Demand Flow Rate, v_p (pc/h/ln)	618	953	334
Capacity Flow Rate, c (pc/h/ln)	2,200	2,200	1,900
v/c ratio	0.28	0.43	0.18
Density, D_{MD} (pc/mi/ln)	10.8	16.7	5.8
LOS	B	B	A

Formulas and Reference Material

$$f_{HV} = \frac{1}{1+P_T(E_T-1)+P_R(E_R-1)}$$ HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P}$$ HCM 2010, Equation 11-2

$$D_{MD} = \frac{0.0175*v_f}{N}$$ HCM 2010, Equation 13-26

Ramp Roadways Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

Diverge LOS Thresholds

LOS	Density (pc/mi/ln)
A	≤10
B	>10-20
C	>20-28
D	>28-35
E	>35
F	v/c > 1

Source: HCM 2010, Exhibit 13-2

RAMP ADD OR DROP LANE ANALYSIS (MAINLINE <55 MPH)

ATKINS

General Information

Date Performed:	7/25/2014	Freeway/Direction	I-26 EB C-D
Analysis Year	2018 No Action	Junction	WB Aviation EB On Loop
Analysis Time Period:	PM Peak	Segment ID	1030
Project Description:	Navy Base ICTF		

Inputs

	Mainline Upstream Ramp	Mainline Downstream Ramp	Ramp
Number of Lanes, N	1	1	1
Free-Flow Speed, FFS (mph)	55	55	25
Volume, V (veh/h)	352	823	471
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	9%	5%	2%
%RVs, P_R	0%	0%	0%

Performance Measures

	Upstream of Off-Ramp	Downstream of Off-Ramp	Off-Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.96	0.98	0.99
Demand Flow Rate, v_p (pc/h/ln)	409	937	529
Capacity Flow Rate, c (pc/h/ln)	2,200	2,200	1,900
v/c ratio	0.19	0.43	0.28
Density, D_{MD} (pc/mi/ln)	7.2	16.4	9.3
LOS	A	B	A

Formulas and Reference Material

$$f_{HV} = \frac{1}{1+P_T(E_T-1)+P_R(E_R-1)}$$ HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P}$$ HCM 2010, Equation 11-2

$$D_{MD} = \frac{0.0175*v_f}{N}$$ HCM 2010, Equation 13-26

Ramp Roadways Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

Diverge LOS Thresholds

LOS	Density (pc/mi/ln)
A	≤10
B	>10-20
C	>20-28
D	>28-35
E	>35
F	v/c > 1

Source: HCM 2010, Exhibit 13-2

Navy Base ICTF

FREEWAY WEAVING WORKSHEET

General Information

Analyst	AJR
Agency/Company	Atkins
Date Performed	7/25/2014
Analysis Time Period	AM Peak

Site Information

Freeway/Dir of Travel	I-26 EB - Aviation-Remount C-D
Weaving Segment Location	1040-EB Aviation to Remount
Analysis Year	2018 No Action

Project Description *Navy Base ICTF*

Inputs

Weaving configuration	One-Sided
Weaving number of lanes, N	2
Weaving segment length, L_S	535ft
Freeway free-flow speed, FFS	55 mph
Segment type	C-D Roadway/ Multilane Highways
Freeway minimum speed, S_{MIN}	15
Freeway maximum capacity, C_{IFL}	2250
Terrain type	Level

Conversions to pc/h Under Base Conditions

	V (veh/h)	PHF	Truck (%)	RV (%)	E_T	E_R	f_{HV}	f_p	v (pc/h)
V_{FF}	296	0.90	3	0	1.5	1.2	0.985	1.00	334
V_{RF}	203	0.90	7	0	1.5	1.2	0.966	1.00	233
V_{FR}	537	0.90	7	0	1.5	1.2	0.966	1.00	618
V_{RR}	0	0.90	0	0	1.5	1.2	1.000	1.00	0
V_{NW}	334							V =	1185
V_W	851								
VR	0.718								

Configuration Characteristics

Minimum maneuver lanes, N_{WL}	2 lc	Minimum weaving lane changes, LC_{MIN}	851 lc/h
Interchange density, ID	0.8 int/mi	Weaving lane changes, LC_W	889 lc/h
Minimum RF lane changes, LC_{RF}	1 lc/pc	Non-weaving lane changes, LC_{NW}	0 lc/h
Minimum FR lane changes, LC_{FR}	1 lc/pc	Total lane changes, LC_{ALL}	889 lc/h
Minimum RR lane changes, LC_{RR}	lc/pc	Non-weaving vehicle index, I_{NW}	14

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment flow rate, v	1185 pc/h	Weaving intensity factor, W	0.337
Weaving segment capacity, c_w	2934 veh/h	Weaving segment speed, S	45.2 mph
Weaving segment v/c ratio	0.398	Average weaving speed, S_W	44.9 mph
Weaving segment density, D	13.1 pc/mi/ln	Average non-weaving speed, S_{NW}	46.0 mph
Level of Service, LOS	B	Maximum weaving length, L_{MAX}	10486 ft

Notes

a. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments".
b. For volumes that exceed the weaving segment capacity, the level of service is "F".

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Navy Base ICTF

FREEWAY WEAVING WORKSHEET

General Information

Analyst	AJR
Agency/Company	Atkins
Date Performed	7/25//2014
Analysis Time Period	PM Peak

Site Information

Freeway/Dir of Travel	I-26 EB - Aviation-Remount C-D
Weaving Segment Location	1040-EB Aviation to Remount
Analysis Year	2018 No-Action

Project Description *Navy Base ICTF*

Inputs

Weaving configuration	One-Sided
Weaving number of lanes, N	2
Weaving segment length, L_S	535ft
Freeway free-flow speed, FFS	55 mph
Segment type	C-D Roadway/ Multilane Highways
Freeway minimum speed, S_{MIN}	15
Freeway maximum capacity, C_{IFL}	2250
Terrain type	Level

Conversions to pc/h Under Base Conditions

	V (veh/h)	PHF	Truck (%)	RV (%)	E_T	E_R	f_{HV}	f_p	v (pc/h)
V_{FF}	471	0.90	2	0	1.5	1.2	0.990	1.00	529
V_{RF}	362	0.90	3	0	1.5	1.2	0.985	1.00	408
V_{FR}	352	0.90	9	0	1.5	1.2	0.957	1.00	409
V_{RR}	0	0.90	0	0	1.5	1.2	1.000	1.00	0
V_{NW}	529							V =	1346
V_W	817								
VR	0.607								

Configuration Characteristics

Minimum maneuver lanes, N_{WL}	2 lc	Minimum weaving lane changes, LC_{MIN}	817 lc/h
Interchange density, ID	0.8 int/mi	Weaving lane changes, LC_W	855 lc/h
Minimum RF lane changes, LC_{RF}	1 lc/pc	Non-weaving lane changes, LC_{NW}	14 lc/h
Minimum FR lane changes, LC_{FR}	1 lc/pc	Total lane changes, LC_{ALL}	869 lc/h
Minimum RR lane changes, LC_{RR}	lc/pc	Non-weaving vehicle index, I_{NW}	23

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment flow rate, v	1346 pc/h	Weaving intensity factor, W	0.331
Weaving segment capacity, c_w	3156 veh/h	Weaving segment speed, S	45.4 mph
Weaving segment v/c ratio	0.422	Average weaving speed, S_W	45.0 mph
Weaving segment density, D	14.8 pc/mi/ln	Average non-weaving speed, S_{NW}	45.9 mph
Level of Service, LOS	B	Maximum weaving length, L_{MAX}	9103 ft

Notes

a. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments".
b. For volumes that exceed the weaving segment capacity, the level of service is "F".

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-26 EB C-D*
Agency or Company	*Atkins*	From/To	*1045-Remount Off to Remount On*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2018 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*998*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*5*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.976*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*55.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*55.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*568*	pc/h/ln
S	*55.0*	mph
D = v_p / S	*10.3*	pc/mi/ln
LOS	*A*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-26 EB C-D*
Agency or Company	*Atkins*	From/To	*1045-Remount Off to Remount On*
Date Performed	*4/25/2014*	Jurisdiction	
Analysis Time Period	*PM Peak*	Analysis Year	*2018 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*1666*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*2*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.990*

Speed Inputs			Calc Speed Adj and FFS		
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f_{LW}		mph
Number of Lanes, N	*2*		f_{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	*55.0*	mph	FFS	*55.0*	mph
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures			Design (N)	
Operational (LOS)			Design (N)	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*935*	pc/h/ln	Design LOS	
			v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h/ln
S	*55.0*	mph	S	mph
D = v_p / S	*17.0*	pc/mi/ln	D = v_p / S	pc/mi/ln
LOS	*B*		Required Number of Lanes, N	

Glossary		Factor Location	
N - Number of lanes	S - Speed	E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
V - Hourly volume	D - Density	E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 11-18	TRD - Page 11-11
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 11-2, 11-3	
DDHV - Directional design hour volume			

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RAMP ADD OR DROP LANE ANALYSIS (MAINLINE <55 MPH)

ATKINS

General Information

Date Performed:	7/25/2014	Freeway/Direction	I-26 EB C-D
Analysis Year	2018 No Action	Junction	Remount EB On Loop
Analysis Time Period:	AM Peak	Segment ID	1050
Project Description:	Navy Base ICTF		

Inputs

	Mainline Upstream Ramp	Mainline Downstream Ramp	Ramp
Number of Lanes, N	1	1	1
Free-Flow Speed, FFS (mph)	55	55	25
Volume, V (veh/h)	499	854	355
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	5%	4%	3%
%RVs, P_R	0%	0%	0%

Performance Measures

	Upstream of Off-Ramp	Downstream of Off-Ramp	Off-Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.98	0.98	0.99
Demand Flow Rate, v_p (pc/h/ln)	568	968	400
Capacity Flow Rate, c (pc/h/ln)	2,200	2,200	1,900
v/c ratio	0.26	0.44	0.21
Density, D_{MD} (pc/mi/ln)	9.9	16.9	7.0
LOS	A	B	A

Formulas and Reference Material

$$f_{HV} = \frac{1}{1+P_T(E_T-1)+P_R(E_R-1)}$$ HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P}$$ HCM 2010, Equation 11-2

$$D_{MD} = \frac{0.0175*v_f}{N}$$ HCM 2010, Equation 13-26

Ramp Roadways Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

Diverge LOS Thresholds

LOS	Density (pc/mi/ln)
A	≤10
B	>10-20
C	>20-28
D	>28-35
E	>35
F	v/c > 1

Source: HCM 2010, Exhibit 13-2

RAMP ADD OR DROP LANE ANALYSIS (MAINLINE <55 MPH)

ATKINS

General Information

Date Performed:	3/20/2014	Freeway/Direction	I-26 EB C-D
Analysis Year	2018 No Action	Junction	Remount EB On Loop
Analysis Time Period:	PM Peak	Segment ID	1050
Project Description:	Navy Base ICTF		

Inputs

	Mainline Upstream Ramp	Mainline Downstream Ramp	Ramp
Number of Lanes, N	1	1	1
Free-Flow Speed, FFS (mph)	55	55	25
Volume, V (veh/h)	833	1,242	409
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	2%	2%	2%
%RVs, P_R	0%	0%	0%

Performance Measures

	Upstream of Off-Ramp	Downstream of Off-Ramp	Off-Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.99	0.99	0.99
Demand Flow Rate, v_p (pc/h/ln)	935	1,394	459
Capacity Flow Rate, c (pc/h/ln)	2,200	2,200	1,900
v/c ratio	0.43	0.63	0.24
Density, D_{MD} (pc/mi/ln)	16.4	24.4	8.0
LOS	B	C	A

Formulas and Reference Material

$$f_{HV} = \frac{1}{1+P_T(E_T-1)+P_R(E_R-1)}$$ HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P}$$ HCM 2010, Equation 11-2

$$D_{MD} = \frac{0.0175*v_f}{N}$$ HCM 2010, Equation 13-26

Ramp Roadways Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

Diverge LOS Thresholds

LOS	Density (pc/mi/ln)
A	≤10
B	>10-20
C	>20-28
D	>28-35
E	>35
F	v/c > 1

Source: HCM 2010, Exhibit 13-2

Navy Base ICTF

FREEWAY WEAVING WORKSHEET

General Information

Analyst	AJR
Agency/Company	Atkins
Date Performed	7/25/2014
Analysis Time Period	AM Peak

Site Information

Freeway/Dir of Travel	I-26 EB
Weaving Segment Location	1060-Avi-Rem C-D to 526 C-D
Analysis Year	2018 No Action

Project Description *Navy Base ICTF*

Inputs

Weaving configuration	One-Sided	Segment type	Freeway
Weaving number of lanes, N	5	Freeway minimum speed, S_{MIN}	15
Weaving segment length, L_S	1850ft	Freeway maximum capacity, C_{IFL}	2300
Freeway free-flow speed, FFS	60 mph	Terrain type	Level

Conversions to pc/h Under Base Conditions

	V (veh/h)	PHF	Truck (%)	RV (%)	E_T	E_R	f_{HV}	f_p	v (pc/h)
V_{FF}	4116	0.90	13	0	1.5	1.2	0.939	1.00	4871
V_{RF}	477	0.90	13	0	1.5	1.2	0.939	1.00	564
V_{FR}	3257	0.90	32	0	1.5	1.2	0.862	1.00	4198
V_{RR}	377	0.90	32	0	1.5	1.2	0.862	1.00	486
V_{NW}	5357							V =	10119
V_W	4762								
VR	0.471								

Configuration Characteristics

Minimum maneuver lanes, N_{WL}	2 lc	Minimum weaving lane changes, LC_{MIN}	lc/h
Interchange density, ID	0.7 int/mi	Weaving lane changes, LC_W	lc/h
Minimum RF lane changes, LC_{RF}	2 lc/pc	Non-weaving lane changes, LC_{NW}	lc/h
Minimum FR lane changes, LC_{FR}	0 lc/pc	Total lane changes, LC_{ALL}	lc/h
Minimum RR lane changes, LC_{RR}	lc/pc	Non-weaving vehicle index, I_{NW}	631

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment flow rate, v	10119 pc/h	Weaving intensity factor, W	
Weaving segment capacity, c_w	4789 veh/h	Weaving segment speed, S	mph
Weaving segment v/c ratio	1.984	Average weaving speed, S_W	mph
Weaving segment density, D	pc/mi/ln	Average non-weaving speed, S_{NW}	mph
Level of Service, LOS	F	Maximum weaving length, L_{MAX}	7485 ft

Notes

a. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments".
b. For volumes that exceed the weaving segment capacity, the level of service is "F".

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Navy Base ICTF

FREEWAY WEAVING WORKSHEET

General Information

Analyst	AJR
Agency/Company	Atkins
Date Performed	7/25/2014
Analysis Time Period	PM Peak

Site Information

Freeway/Dir of Travel	I-26 EB
Weaving Segment Location	1060-Avi-Rem C-D to 526 C-D
Analysis Year	2018 No Action

Project Description *Navy Base ICTF*

Inputs

Weaving configuration	One-Sided
Weaving number of lanes, N	5
Weaving segment length, L_S	1850ft
Freeway free-flow speed, FFS	60 mph
Segment type	Freeway
Freeway minimum speed, S_{MIN}	15
Freeway maximum capacity, C_{IFL}	2300
Terrain type	Level

Conversions to pc/h Under Base Conditions

	V (veh/h)	PHF	Truck (%)	RV (%)	E_T	E_R	f_{HV}	f_p	v (pc/h)
V_{FF}	2747	0.90	10	0	1.5	1.2	0.952	1.00	3205
V_{RF}	668	0.90	10	0	1.5	1.2	0.952	1.00	779
V_{FR}	2362	0.90	34	0	1.5	1.2	0.855	1.00	3071
V_{RR}	574	0.90	34	0	1.5	1.2	0.855	1.00	746
V_{NW}	3951							V =	7801
V_W	3850								
VR	0.494								

Configuration Characteristics

Minimum maneuver lanes, N_{WL}	2 lc	Minimum weaving lane changes, LC_{MIN}	lc/h
Interchange density, ID	0.7 int/mi	Weaving lane changes, LC_W	lc/h
Minimum RF lane changes, LC_{RF}	2 lc/pc	Non-weaving lane changes, LC_{NW}	lc/h
Minimum FR lane changes, LC_{FR}	0 lc/pc	Total lane changes, LC_{ALL}	lc/h
Minimum RR lane changes, LC_{RR}	lc/pc	Non-weaving vehicle index, I_{NW}	415

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment flow rate, v	7801 pc/h	Weaving intensity factor, W	
Weaving segment capacity, c_w	4631 veh/h	Weaving segment speed, S	mph
Weaving segment v/c ratio	1.604	Average weaving speed, S_W	mph
Weaving segment density, D	pc/mi/ln	Average non-weaving speed, S_{NW}	mph
Level of Service, LOS	F	Maximum weaving length, L_{MAX}	7751 ft

Notes

a. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments".
b. For volumes that exceed the weaving segment capacity, the level of service is "F".

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-26 EB*
Agency or Company	*Atkins*	From/To	*1065 - I-526 CD Off to CD On*
Date Performed	*4/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2018 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*4593*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*13*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.939*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*3*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*60.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*60.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1812*	pc/h/ln
S	*59.2*	mph
D = v_p / S	*30.6*	pc/mi/ln
LOS	*D*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-26 EB*
Agency or Company	*Atkins*	From/To	*1065 - I-526 CD Off to CD On*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*PM Peak*	Analysis Year	*2018 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*3415*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*10*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.952*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*3*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*60.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*60.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1328*	pc/h/ln
S	*60.0*	mph
D = v_p / S	*22.1*	pc/mi/ln
LOS	*C*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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RAMP ADD OR DROP LANE ANALYSIS (MAINLINE <55 MPH)

ATKINS

General Information

Date Performed:	7/25/2014	Freeway/Direction	I-26 EB C-D
Analysis Year	2018 No Action	Junction	EB Off to I-526 WB
Analysis Time Period:	AM Peak	Segment ID	1070
Project Description:	Navy Base ICTF		

Inputs

	Mainline Upstream Ramp	Mainline Downstream Ramp	Ramp
Number of Lanes, N	2	1	1
Free-Flow Speed, FFS (mph)	55	55	45
Volume, V (veh/h)	3,634	1,413	2,221
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	32%	52%	20%
%RVs, P_R	0%	0%	0%

Performance Measures

	Upstream of Off-Ramp	Downstream of Off-Ramp	Off-Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.86	0.79	0.91
Demand Flow Rate, v_p (pc/h/ln)	2,342	1,978	2,715
Capacity Flow Rate, c (pc/h/ln)	2,200	2,200	2,100
v/c ratio	1.06	0.90	1.29
Density, D_{MD} (pc/mi/ln)	41.0	34.6	47.5
LOS	F	D	F

Formulas and Reference Material

$$f_{HV} = \frac{1}{1+P_T(E_T-1)+P_R(E_R-1)}$$ HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P}$$ HCM 2010, Equation 11-2

$$D_{MD} = \frac{0.0175*v_f}{N}$$ HCM 2010, Equation 13-26

Ramp Roadways Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

Diverge LOS Thresholds

LOS	Density (pc/mi/ln)
A	≤10
B	>10-20
C	>20-28
D	>28-35
E	>35
F	v/c > 1

Source: HCM 2010, Exhibit 13-2

RAMP ADD OR DROP LANE ANALYSIS (MAINLINE <55 MPH)

ATKINS

General Information

Date Performed:	7/25/2014	Freeway/Direction	I-26 EB C-D
Analysis Year	2018 No Action	Junction	EB Off to I-526 WB
Analysis Time Period:	PM Peak	Segment ID	1070
Project Description:	Navy Base ICTF		

Inputs

	Mainline Upstream Ramp	Mainline Downstream Ramp	Ramp
Number of Lanes, N	2	1	1
Free-Flow Speed, FFS (mph)	55	55	45
Volume, V (veh/h)	2,936	1,155	1,781
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	34%	55%	21%
%RVs, P_R	0%	0%	0%

Performance Measures

	Upstream of Off-Ramp	Downstream of Off-Ramp	Off-Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.85	0.78	0.90
Demand Flow Rate, v_p (pc/h/ln)	1,908	1,636	2,187
Capacity Flow Rate, c (pc/h/ln)	2,200	2,200	2,100
v/c ratio	0.87	0.74	1.04
Density, D_{MD} (pc/mi/ln)	33.4	28.6	38.3
LOS	D	D	F

Formulas and Reference Material

$$f_{HV} = \frac{1}{1+P_T(E_T-1)+P_R(E_R-1)}$$ HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P}$$ HCM 2010, Equation 11-2

$$D_{MD} = \frac{0.0175*v_f}{N}$$ HCM 2010, Equation 13-26

Ramp Roadways Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

Diverge LOS Thresholds

LOS	Density (pc/mi/ln)
A	≤10
B	>10-20
C	>20-28
D	>28-35
E	>35
F	v/c > 1

Source: HCM 2010, Exhibit 13-2

BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-26 EB C-D*
Agency or Company	*Atkins*	From/To	*1075-I526 WB Off to I526 WB On*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2018 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*2826*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*52*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.794*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*55.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*55.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1978*	pc/h/ln
S	*54.2*	mph
D = v_p / S	*36.5*	pc/mi/ln
LOS	*E*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-26 EB C-D*
Agency or Company	*Atkins*	From/To	*1075-I526 WB Off to I526 WB On*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*PM Peak*	Analysis Year	*2018 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*2310*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*55*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length	*mi*
			Up/Down %	

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.784*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*55.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*55.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1636*	pc/h/ln
S	*55.0*	mph
D = v_p / S	*29.7*	pc/mi/ln
LOS	*D*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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Navy Base ICTF

FREEWAY WEAVING WORKSHEET

General Information

Analyst	AJR
Agency/Company	Atkins
Date Performed	3/20/2014
Analysis Time Period	AM Peak

Site Information

Freeway/Dir of Travel	I-26 EB C-D
Weaving Segment Location	1080 - I-526 WB to I-526 EB
Analysis Year	2018 No Action

Project Description *Navy Base ICTF*

Inputs

Weaving configuration	One-Sided
Weaving number of lanes, N	2
Weaving segment length, L_S	620ft
Freeway free-flow speed, FFS	55 mph
Segment type	C-D Roadway/ Multilane Highways
Freeway minimum speed, S_{MIN}	15
Freeway maximum capacity, C_{IFL}	2250
Terrain type	Level

Conversions to pc/h Under Base Conditions

	V (veh/h)	PHF	Truck (%)	RV (%)	E_T	E_R	f_{HV}	f_p	v (pc/h)
V_{FF}	0	0.90	0	0	1.5	1.2	1.000	1.00	0
V_{RF}	538	0.90	8	0	1.5	1.2	0.962	1.00	622
V_{FR}	1413	0.90	52	0	1.5	1.2	0.794	1.00	1978
V_{RR}	0	0.90	0	0	1.5	1.2	1.000	1.00	0
V_{NW}	0							V =	2600
V_W	2600								
VR	1.000								

Configuration Characteristics

Minimum maneuver lanes, N_{WL}	2 lc	Minimum weaving lane changes, LC_{MIN}	lc/h
Interchange density, ID	0.8 int/mi	Weaving lane changes, LC_W	lc/h
Minimum RF lane changes, LC_{RF}	1 lc/pc	Non-weaving lane changes, LC_{NW}	lc/h
Minimum FR lane changes, LC_{FR}	1 lc/pc	Total lane changes, LC_{ALL}	lc/h
Minimum RR lane changes, LC_{RR}	lc/pc	Non-weaving vehicle index, I_{NW}	0

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment flow rate, v	2600 pc/h	Weaving intensity factor, W	
Weaving segment capacity, c_w	2400 veh/h	Weaving segment speed, S	mph
Weaving segment v/c ratio	1.083	Average weaving speed, S_W	mph
Weaving segment density, D	pc/mi/ln	Average non-weaving speed, S_{NW}	mph
Level of Service, LOS	F	Maximum weaving length, L_{MAX}	14232 ft

Notes

a. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments".
b. For volumes that exceed the weaving segment capacity, the level of service is "F".

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Navy Base ICTF

FREEWAY WEAVING WORKSHEET

General Information

Analyst	AJR
Agency/Company	Atkins
Date Performed	7/25/2014
Analysis Time Period	PM Peak

Site Information

Freeway/Dir of Travel	I-26 EB C-D
Weaving Segment Location	1080 - I-526 WB to I-526 EB
Analysis Year	2018 No Action

Project Description *Navy Base ICTF*

Inputs

Weaving configuration	One-Sided
Weaving number of lanes, N	2
Weaving segment length, L_S	620ft
Freeway free-flow speed, FFS	55 mph
Segment type	C-D Roadway/ Multilane Highways
Freeway minimum speed, S_{MIN}	15
Freeway maximum capacity, C_{IFL}	2250
Terrain type	Level

Conversions to pc/h Under Base Conditions

	V (veh/h)	PHF	Truck (%)	RV (%)	E_T	E_R	f_{HV}	f_p	v (pc/h)
V_{FF}	0	0.90	0	0	1.5	1.2	1.000	1.00	0
V_{RF}	474	0.90	8	0	1.5	1.2	0.962	1.00	548
V_{FR}	1155	0.90	55	0	1.5	1.2	0.784	1.00	1636
V_{RR}	0	0.90	0	0	1.5	1.2	1.000	1.00	0
V_{NW}	0							V =	2184
V_W	2184								
VR	1.000								

Configuration Characteristics

Minimum maneuver lanes, N_{WL}	2 lc	Minimum weaving lane changes, LC_{MIN}	2184 lc/h
Interchange density, ID	0.8 int/mi	Weaving lane changes, LC_W	2229 lc/h
Minimum RF lane changes, LC_{RF}	1 lc/pc	Non-weaving lane changes, LC_{NW}	0 lc/h
Minimum FR lane changes, LC_{FR}	1 lc/pc	Total lane changes, LC_{ALL}	2229 lc/h
Minimum RR lane changes, LC_{RR}	lc/pc	Non-weaving vehicle index, I_{NW}	0

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment flow rate, v	2184 pc/h	Weaving intensity factor, W	0.620
Weaving segment capacity, c_w	2400 veh/h	Weaving segment speed, S	39.7 mph
Weaving segment v/c ratio	0.910	Average weaving speed, S_W	39.7 mph
Weaving segment density, D	27.5 pc/mi/ln	Average non-weaving speed, S_{NW}	34.0 mph
Level of Service, LOS	C	Maximum weaving length, L_{MAX}	14232 ft

Notes

a. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments".
b. For volumes that exceed the weaving segment capacity, the level of service is "F".

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-26 EB C-D*
Agency or Company	*Atkins*	From/To	*1085-I526 EB Off to I526 EB On*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2018 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*1076*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*8*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.962*

Speed Inputs			Calc Speed Adj and FFS		
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f_{LW}		mph
Number of Lanes, N	*2*		f_{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	*55.0*	mph	FFS	*55.0*	mph
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures			Design (N)	
Operational (LOS)			Design (N)	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*622*	pc/h/ln	Design LOS	
			v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h/ln
S	*55.0*	mph	S	mph
D = v_p / S	*11.3*	pc/mi/ln	D = v_p / S	pc/mi/ln
LOS	*B*		Required Number of Lanes, N	

Glossary		Factor Location	
N - Number of lanes	S - Speed	E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
V - Hourly volume	D - Density	E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 11-18	TRD - Page 11-11
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 11-2, 11-3	
DDHV - Directional design hour volume			

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F-2667

BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-26 EB C-D*
Agency or Company	*Atkins*	From/To	*1085-I526 EB Off to I526 EB On*
Date Performed	*4/25/2014*	Jurisdiction	
Analysis Time Period	*PM Peak*	Analysis Year	*2018 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*948*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*8*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.962*

Speed Inputs			Calc Speed Adj and FFS		
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f_{LW}		mph
Number of Lanes, N	*2*		f_{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	*55.0*	mph	FFS	*55.0*	mph
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures			Design (N)	
Operational (LOS)			Design (N)	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*548*	pc/h/ln	Design LOS	
			v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h/ln
S	*55.0*	mph	S	mph
D = v_p / S	*10.0*	pc/mi/ln	D = v_p / S	pc/mi/ln
LOS	*A*		Required Number of Lanes, N	

Glossary		Factor Location	
N - Number of lanes	S - Speed	E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
V - Hourly volume	D - Density	E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 11-18	TRD - Page 11-11
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 11-2, 11-3	
DDHV - Directional design hour volume			

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F-2668

RAMP ADD OR DROP LANE ANALYSIS (MAINLINE <55 MPH)

ATKINS

General Information

Date Performed:	7/25/2014	Freeway/Direction	I-26 EB
Analysis Year	2018 No Action	Junction	I-526 EB Ramp Split
Analysis Time Period:	AM Peak	Segment ID	1088
Project Description:	Navy Base ICTF		

Inputs

	Mainline Upstream Ramp	Mainline Downstream Ramp	Ramp
Number of Lanes, N	2	2	1
Free-Flow Speed, FFS (mph)	55	55	55
Volume, V (veh/h)	2,123	1,824	299
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	11%	13%	3%
%RVs, P_R	0%	0%	0%

Performance Measures

	Upstream of Off-Ramp	Downstream of Off-Ramp	Off-Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.95	0.94	0.99
Demand Flow Rate, v_p (pc/h/ln)	1,244	1,079	337
Capacity Flow Rate, c (pc/h/ln)	2,200	2,200	2,200
v/c ratio	0.57	0.49	0.15
Density, D_{MD} (pc/mi/ln)	21.8	18.9	5.9
LOS	C	B	A

Formulas and Reference Material

$$f_{HV} = \frac{1}{1+P_T(E_T-1)+P_R(E_R-1)}$$ HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P}$$ HCM 2010, Equation 11-2

$$D_{MD} = \frac{0.0175*v_f}{N}$$ HCM 2010, Equation 13-26

Ramp Roadways Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

Diverge LOS Thresholds

LOS	Density (pc/mi/ln)
A	≤10
B	>10-20
C	>20-28
D	>28-35
E	>35
F	v/c > 1

Source: HCM 2010, Exhibit 13-2

RAMP ADD OR DROP LANE ANALYSIS (MAINLINE <55 MPH)

ATKINS

General Information

Date Performed:	3/20/2014	Freeway/Direction	I-26 EB
Analysis Year	2018 No Action	Junction	I-526 EB Ramp Split
Analysis Time Period:	PM Peak	Segment ID	1088
Project Description:	Navy Base ICTF		

Inputs

	Mainline Upstream Ramp	Mainline Downstream Ramp	Ramp
Number of Lanes, N	2	2	1
Free-Flow Speed, FFS (mph)	55	55	55
Volume, V (veh/h)	2,453	2,109	344
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	8%	9%	3%
%RVs, P_R	0%	0%	0%

Performance Measures

	Upstream of Off-Ramp	Downstream of Off-Ramp	Off-Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.96	0.96	0.99
Demand Flow Rate, v_p (pc/h/ln)	1,417	1,224	388
Capacity Flow Rate, c (pc/h/ln)	2,200	2,200	2,200
v/c ratio	0.64	0.56	0.18
Density, D_{MD} (pc/mi/ln)	24.8	21.4	6.8
LOS	C	C	A

Formulas and Reference Material

$$f_{HV} = \frac{1}{1+P_T(E_T-1)+P_R(E_R-1)}$$ HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P}$$ HCM 2010, Equation 11-2

$$D_{MD} = \frac{0.0175*v_f}{N}$$ HCM 2010, Equation 13-26

Ramp Roadways Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

Diverge LOS Thresholds

LOS	Density (pc/mi/ln)
A	≤10
B	>10-20
C	>20-28
D	>28-35
E	>35
F	v/c > 1

Source: HCM 2010, Exhibit 13-2

RAMP ADD OR DROP LANE ANALYSIS (MAINLINE <55 MPH)

ATKINS

General Information

Date Performed:	3/20/2014	Freeway/Direction	I-26 EB C-D
Analysis Year	2018 No Action	Junction	I-526 EB On
Analysis Time Period:	AM Peak	Segment ID	1090
Project Description:	Navy Base ICTF		

Inputs

	Mainline Upstream Ramp	Mainline Downstream Ramp	Ramp
Number of Lanes, N	1	1	1
Free-Flow Speed, FFS (mph)	55	55	45
Volume, V (veh/h)	538	837	299
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	8%	6%	3%
%RVs, P_R	0%	0%	0%

Performance Measures

	Upstream of Off-Ramp	Downstream of Off-Ramp	Off-Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.96	0.97	0.99
Demand Flow Rate, v_p (pc/h/ln)	622	958	337
Capacity Flow Rate, c (pc/h/ln)	2,200	2,200	2,100
v/c ratio	0.28	0.44	0.16
Density, D_{MD} (pc/mi/ln)	10.9	16.8	5.9
LOS	B	B	A

Formulas and Reference Material

$$f_{HV} = \frac{1}{1+P_T(E_T-1)+P_R(E_R-1)}$$ HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P}$$ HCM 2010, Equation 11-2

$$D_{MD} = \frac{0.0175*v_f}{N}$$ HCM 2010, Equation 13-26

Ramp Roadways Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

Diverge LOS Thresholds

LOS	Density (pc/mi/ln)
A	≤10
B	>10-20
C	>20-28
D	>28-35
E	>35
F	v/c > 1

Source: HCM 2010, Exhibit 13-2

RAMP ADD OR DROP LANE ANALYSIS (MAINLINE <55 MPH)

ATKINS

General Information

Date Performed:	7/25/2014	Freeway/Direction	I-26 EB C-D
Analysis Year	2018 No Action	Junction	I-526 EB On
Analysis Time Period:	PM Peak	Segment ID	1090
Project Description:	Navy Base ICTF		

Inputs

	Mainline Upstream Ramp	Mainline Downstream Ramp	Ramp
Number of Lanes, N	1	1	1
Free-Flow Speed, FFS (mph)	55	55	45
Volume, V (veh/h)	474	818	344
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	8%	6%	3%
%RVs, P_R	0%	0%	0%

Performance Measures

	Upstream of Off-Ramp	Downstream of Off-Ramp	Off-Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.96	0.97	0.99
Demand Flow Rate, v_p (pc/h/ln)	548	936	388
Capacity Flow Rate, c (pc/h/ln)	2,200	2,200	2,100
v/c ratio	0.25	0.43	0.18
Density, D_{MD} (pc/mi/ln)	9.6	16.4	6.8
LOS	A	B	A

Formulas and Reference Material

$$f_{HV} = \frac{1}{1+P_T(E_T-1)+P_R(E_R-1)}$$ HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P}$$ HCM 2010, Equation 11-2

$$D_{MD} = \frac{0.0175*v_f}{N}$$ HCM 2010, Equation 13-26

Ramp Roadways Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

Diverge LOS Thresholds

LOS	Density (pc/mi/ln)
A	≤10
B	>10-20
C	>20-28
D	>28-35
E	>35
F	v/c > 1

Source: HCM 2010, Exhibit 13-2

Navy Base ICTF

FREEWAY WEAVING WORKSHEET

General Information

Analyst	AJR
Agency/Company	Atkins
Date Performed	7/25/2014
Analysis Time Period	AM Peak

Site Information

Freeway/Dir of Travel	I-26 EB
Weaving Segment Location	1100 - I-526 CD to Montague SB
Analysis Year	2018 No Action

Project Description *Navy Base ICTF*

Inputs

Weaving configuration	One-Sided
Weaving number of lanes, N	4
Weaving segment length, L_S	1550ft
Freeway free-flow speed, FFS	60 mph
Segment type	Freeway
Freeway minimum speed, S_{MIN}	15
Freeway maximum capacity, C_{IFL}	2300
Terrain type	Level

Conversions to pc/h Under Base Conditions

	V (veh/h)	PHF	Truck (%)	RV (%)	E_T	E_R	f_{HV}	f_p	v (pc/h)
V_{FF}	4036	0.90	4	0	1.5	1.2	0.980	1.00	4574
V_{RF}	736	0.90	6	0	1.5	1.2	0.971	1.00	842
V_{FR}	557	0.90	14	0	1.5	1.2	0.935	1.00	662
V_{RR}	101	0.90	14	0	1.5	1.2	0.935	1.00	120
V_{NW}	4694							V =	6198
V_W	1504								
VR	0.243								

Configuration Characteristics

Minimum maneuver lanes, N_{WL}	2 lc	Minimum weaving lane changes, LC_{MIN}	1504 lc/h
Interchange density, ID	0.8 int/mi	Weaving lane changes, LC_W	1857 lc/h
Minimum RF lane changes, LC_{RF}	1 lc/pc	Non-weaving lane changes, LC_{NW}	1037 lc/h
Minimum FR lane changes, LC_{FR}	1 lc/pc	Total lane changes, LC_{ALL}	2894 lc/h
Minimum RR lane changes, LC_{RR}	lc/pc	Non-weaving vehicle index, I_{NW}	582

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment flow rate, v	6198 pc/h	Weaving intensity factor, W	0.370
Weaving segment capacity, c_w	7992 veh/h	Weaving segment speed, S	43.1 mph
Weaving segment v/c ratio	0.760	Average weaving speed, S_W	47.8 mph
Weaving segment density, D	36.0 pc/mi/ln	Average non-weaving speed, S_{NW}	41.7 mph
Level of Service, LOS	E	Maximum weaving length, L_{MAX}	4977 ft

Notes

a. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments".
b. For volumes that exceed the weaving segment capacity, the level of service is "F".

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Navy Base ICTF

FREEWAY WEAVING WORKSHEET

General Information

Analyst	AJR
Agency/Company	Atkins
Date Performed	3/20/2014
Analysis Time Period	PM Peak

Site Information

Freeway/Dir of Travel	I-26 EB
Weaving Segment Location	1100 - I-526 CD to Montague SB
Analysis Year	2018 No Action

Project Description *Navy Base ICTF*

Inputs

Weaving configuration	One-Sided
Weaving number of lanes, N	4
Weaving segment length, L_S	1550ft
Freeway free-flow speed, FFS	60 mph
Segment type	Freeway
Freeway minimum speed, S_{MIN}	15
Freeway maximum capacity, C_{IFL}	2300
Terrain type	Level

Conversions to pc/h Under Base Conditions

	V (veh/h)	PHF	Truck (%)	RV (%)	E_T	E_R	f_{HV}	f_p	v (pc/h)
V_{FF}	2610	0.90	3	0	1.5	1.2	0.985	1.00	2944
V_{RF}	625	0.90	6	0	1.5	1.2	0.971	1.00	715
V_{FR}	805	0.90	8	0	1.5	1.2	0.962	1.00	930
V_{RR}	193	0.90	8	0	1.5	1.2	0.962	1.00	223
V_{NW}	3167							V =	4812
V_W	1645								
VR	0.342								

Configuration Characteristics

Minimum maneuver lanes, N_{WL}	2 lc	Minimum weaving lane changes, LC_{MIN}	1645 lc/h
Interchange density, ID	0.8 int/mi	Weaving lane changes, LC_W	1998 lc/h
Minimum RF lane changes, LC_{RF}	1 lc/pc	Non-weaving lane changes, LC_{NW}	722 lc/h
Minimum FR lane changes, LC_{FR}	1 lc/pc	Total lane changes, LC_{ALL}	2720 lc/h
Minimum RR lane changes, LC_{RR}	lc/pc	Non-weaving vehicle index, I_{NW}	393

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment flow rate, v	4812 pc/h	Weaving intensity factor, W	0.352
Weaving segment capacity, c_w	6917 veh/h	Weaving segment speed, S	44.2 mph
Weaving segment v/c ratio	0.685	Average weaving speed, S_W	48.3 mph
Weaving segment density, D	27.2 pc/mi/ln	Average non-weaving speed, S_{NW}	42.4 mph
Level of Service, LOS	C	Maximum weaving length, L_{MAX}	6037 ft

Notes

a. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments".
b. For volumes that exceed the weaving segment capacity, the level of service is "F".

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-26 EB*
Agency or Company	*Atkins*	From/To	*1105-Mont SB Off to Mont SB On*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2018 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*4772*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*4*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.980*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*3*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*60.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*60.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1803*	pc/h/ln
S	*59.3*	mph
D = v_p / S	*30.4*	pc/mi/ln
LOS	*D*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-26 EB*
Agency or Company	*Atkins*	From/To	*1105-Mont SB Off to Mont SB On*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*PM Peak*	Analysis Year	*2018 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*3235*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*3*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.985*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*3*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*60.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*60.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1216*	pc/h/ln
S	*60.0*	mph
D = v_p / S	*20.3*	pc/mi/ln
LOS	*C*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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F-2676

Navy Base ICTF

FREEWAY WEAVING WORKSHEET

General Information

Analyst	AJR
Agency/Company	Atkins
Date Performed	7/25/2014
Analysis Time Period	AM Peak

Site Information

Freeway/Dir of Travel	I-26 EB
Weaving Segment Location	1110 - Montague SB to Mont. NB
Analysis Year	2018 No Action

Project Description *Navy Base ICTF*

Inputs

Weaving configuration	One-Sided	Segment type	Freeway
Weaving number of lanes, N	4	Freeway minimum speed, S_{MIN}	15
Weaving segment length, L_S	470ft	Freeway maximum capacity, C_{IFL}	2300
Freeway free-flow speed, FFS	60 mph	Terrain type	Level

Conversions to pc/h Under Base Conditions

	V (veh/h)	PHF	Truck (%)	RV (%)	E_T	E_R	f_{HV}	f_p	v (pc/h)
V_{FF}	4323	0.90	4	0	1.5	1.2	0.980	1.00	4899
V_{RF}	363	0.90	9	0	1.5	1.2	0.957	1.00	421
V_{FR}	449	0.90	6	0	1.5	1.2	0.971	1.00	514
V_{RR}	0	0.90	0	0	1.5	1.2	1.000	1.00	0
V_{NW}	4899							V =	5834
V_W	935								
VR	0.160								

Configuration Characteristics

Minimum maneuver lanes, N_{WL}	2 lc	Minimum weaving lane changes, LC_{MIN}	935 lc/h
Interchange density, ID	1.0 int/mi	Weaving lane changes, LC_W	1077 lc/h
Minimum RF lane changes, LC_{RF}	1 lc/pc	Non-weaving lane changes, LC_{NW}	494 lc/h
Minimum FR lane changes, LC_{FR}	1 lc/pc	Total lane changes, LC_{ALL}	1571 lc/h
Minimum RR lane changes, LC_{RR}	lc/pc	Non-weaving vehicle index, I_{NW}	230

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment flow rate, v	5834 pc/h	Weaving intensity factor, W	0.586
Weaving segment capacity, c_w	7922 veh/h	Weaving segment speed, S	45.8 mph
Weaving segment v/c ratio	0.722	Average weaving speed, S_W	43.4 mph
Weaving segment density, D	31.9 pc/mi/ln	Average non-weaving speed, S_{NW}	46.3 mph
Level of Service, LOS	D	Maximum weaving length, L_{MAX}	4134 ft

Notes

a. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments".
b. For volumes that exceed the weaving segment capacity, the level of service is "F".

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Navy Base ICTF

FREEWAY WEAVING WORKSHEET

General Information

Analyst	AJR
Agency/Company	Atkins
Date Performed	7/25/2014
Analysis Time Period	PM Peak

Site Information

Freeway/Dir of Travel	I-26 EB
Weaving Segment Location	1110 - Montague SB to Mont. NB
Analysis Year	2018 No Action

Project Description *Navy Base ICTF*

Inputs

Weaving configuration	One-Sided
Weaving number of lanes, N	4
Weaving segment length, L_S	470ft
Freeway free-flow speed, FFS	60 mph
Segment type	Freeway
Freeway minimum speed, S_{MIN}	15
Freeway maximum capacity, C_{IFL}	2300
Terrain type	Level

Conversions to pc/h Under Base Conditions

	V (veh/h)	PHF	Truck (%)	RV (%)	E_T	E_R	f_{HV}	f_p	v (pc/h)
V_{FF}	2988	0.90	3	0	1.5	1.2	0.985	1.00	3370
V_{RF}	449	0.90	6	0	1.5	1.2	0.971	1.00	514
V_{FR}	247	0.90	9	0	1.5	1.2	0.957	1.00	287
V_{RR}	0	0.90	0	0	1.5	1.2	1.000	1.00	0
V_{NW}	3370							V =	4171
V_W	801								
VR	0.192								

Configuration Characteristics

Minimum maneuver lanes, N_{WL}	2 lc	Minimum weaving lane changes, LC_{MIN}	801 lc/h
Interchange density, ID	1.0 int/mi	Weaving lane changes, LC_W	943 lc/h
Minimum RF lane changes, LC_{RF}	1 lc/pc	Non-weaving lane changes, LC_{NW}	179 lc/h
Minimum FR lane changes, LC_{FR}	1 lc/pc	Total lane changes, LC_{ALL}	1122 lc/h
Minimum RR lane changes, LC_{RR}	lc/pc	Non-weaving vehicle index, I_{NW}	158

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment flow rate, v	4171 pc/h	Weaving intensity factor, W	0.449
Weaving segment capacity, c_w	7862 veh/h	Weaving segment speed, S	48.6 mph
Weaving segment v/c ratio	0.523	Average weaving speed, S_W	46.1 mph
Weaving segment density, D	21.5 pc/mi/ln	Average non-weaving speed, S_{NW}	49.2 mph
Level of Service, LOS	C	Maximum weaving length, L_{MAX}	4455 ft

Notes

a. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments".
b. For volumes that exceed the weaving segment capacity, the level of service is "F".

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-26 EB*
Agency or Company	*Atkins*	From/To	*1115-Mont NB Off to Mont NB On*
Date Performed	*4/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2018 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*4686*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*4*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.980*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*3*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*60.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*60.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1770*	pc/h/ln
S	*59.5*	mph
D = v_p / S	*29.8*	pc/mi/ln
LOS	*D*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-26 EB*
Agency or Company	*Atkins*	From/To	*1115-Mont NB Off to Mont NB On*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*PM Peak*	Analysis Year	*2018 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*3437*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*3*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.985*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*3*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*60.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*60.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1292*	pc/h/ln
S	*60.0*	mph
D = v_p / S	*21.5*	pc/mi/ln
LOS	*C*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-26 EB
Agency or Company	Atkins	Junction	1120 - EB On from Montague NB
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2018 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Number of Lanes, N: 3	☐ Yes ☐ On
☑ No ☐ Off	Acceleration Lane Length, L_A: 850	☑ No ☐ Off
L_{up} = ft	Deceleration Lane Length L_D:	L_{down} = ft
V_u = veh/h	Freeway Volume, V_F: 4686	V_D = veh/h
	Ramp Volume, V_R: 558	
	Freeway Free-Flow Speed, S_{FF}: 60.0	
	Ramp Free-Flow Speed, S_{FR}: 45.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	4686	0.90	Level	4	0	0.980	1.00	5311
Ramp	558	0.90	Level	5	0	0.976	1.00	636
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 0.601 using Equation (Exhibit 13-6)

V_{12} = 3194 pc/h

V_3 or V_{av34} 2117 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	5947	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	3830	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = 29.7 (pc/mi/ln)

LOS = D (Exhibit 13-2)

Speed Determination

M_S = 0.424 (Exibit 13-11)

S_R= 52.4 mph (Exhibit 13-11)

S_0= 54.2 mph (Exhibit 13-11)

S = 53.0 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-26 EB
Agency or Company	Atkins	Junction	1120 - EB On from Montague NB
Date Performed	4/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2018 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Number of Lanes, N: 3	☐ Yes ☐ On
☑ No ☐ Off	Acceleration Lane Length, L_A: 850	☑ No ☐ Off
L_{up} = ft	Deceleration Lane Length L_D:	L_{down} = ft
V_u = veh/h	Freeway Volume, V_F: 3437	V_D = veh/h
	Ramp Volume, V_R: 605	
	Freeway Free-Flow Speed, S_{FF}: 60.0	
	Ramp Free-Flow Speed, S_{FR}: 45.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	3437	0.90	Level	3	0	0.985	1.00	3876
Ramp	605	0.90	Level	4	0	0.980	1.00	686
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 0.601 using Equation (Exhibit 13-6)

V_{12} = 2331 pc/h

V_3 or V_{av34} 1545 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * $V_{12}/2$ ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	4562	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	3017	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = 23.4 (pc/mi/ln)

LOS = C (Exhibit 13-2)

Speed Determination

M_S = 0.324 (Exibit 13-11)

S_R= 54.2 mph (Exhibit 13-11)

S_0= 56.2 mph (Exhibit 13-11)

S = 54.8 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * $V_{12}/2$ ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-26 EB*
Agency or Company	*Atkins*	From/To	*1130 - Montague to Dorchester*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2018 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*5244*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*3*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.985*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*3*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*60.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*60.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1971*	pc/h/ln
S	*57.5*	mph
D = v_p / S	*34.3*	pc/mi/ln
LOS	*D*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-26 EB*
Agency or Company	*Atkins*	From/To	*1130 - Montague to Dorchester*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*PM Peak*	Analysis Year	*2018 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*4042*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*3*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.985*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*3*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*60.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*60.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1519*	pc/h/ln
S	*60.0*	mph
D = v_p / S	*25.3*	pc/mi/ln
LOS	*C*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-26 EB
Agency or Company	Atkins	Junction	1140-EB Off to Dorchester Rd
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2018 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Number of Lanes, N	3	Downstream Adj Ramp	
☐ Yes	☐ On	Acceleration Lane Length, L_A		☐ Yes	☐ On
☑ No	☐ Off	Deceleration Lane Length L_D	380	☑ No	☐ Off
L_{up} =	ft	Freeway Volume, V_F	5244	L_{down} =	ft
V_u =	veh/h	Ramp Volume, V_R	556	V_D =	veh/h
		Freeway Free-Flow Speed, S_{FF}	60.0		
		Ramp Free-Flow Speed, S_{FR}	45.0		

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	5244	0.90	Level	3	0	0.985	1.00	5914
Ramp	556	0.90	Level	12	0	0.943	1.00	655
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 0.582 using Equation (Exhibit 13-7)

V_{12} = 3716 pc/h

V_3 or V_{av34} 2198 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	5914	Exhibit 13-8	6900	No
$V_{FO} = V_F - V_R$	5259	Exhibit 13-8	6900	No
V_R	655	Exhibit 13-10	2100	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	3716	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = 32.8 (pc/mi/ln)

LOS = D (Exhibit 13-2)

Speed Determination

D_s = 0.357 (Exhibit 13-12)

S_R= 53.6 mph (Exhibit 13-12)

S_0= 61.1 mph (Exhibit 13-12)

S = 56.2 mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-26 EB
Agency or Company	Atkins	Junction	1140-EB Off to Dorchester Rd
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2018 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Number of Lanes, N: 3	☐ Yes ☐ On
☑ No ☐ Off	Acceleration Lane Length, L_A:	☑ No ☐ Off
L_{up} = ft	Deceleration Lane Length L_D: 380	L_{down} = ft
V_u = veh/h	Freeway Volume, V_F: 4042	V_D = veh/h
	Ramp Volume, V_R: 379	
	Freeway Free-Flow Speed, S_{FF}: 60.0	
	Ramp Free-Flow Speed, S_{FR}: 45.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	4042	0.90	Level	3	0	0.985	1.00	4558
Ramp	379	0.90	Level	15	0	0.930	1.00	453
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 0.625 using Equation (Exhibit 13-7)

V_{12} = 3019 pc/h

V_3 or V_{av34} 1539 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	4558	Exhibit 13-8	6900	No
$V_{FO} = V_F - V_R$	4105	Exhibit 13-8	6900	No
V_R	453	Exhibit 13-10	2100	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	3019	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = 26.8 (pc/mi/ln)

LOS = C (Exhibit 13-2)

Speed Determination

D_s = 0.339 (Exhibit 13-12)

S_R= 53.9 mph (Exhibit 13-12)

S_0= 63.7 mph (Exhibit 13-12)

S = 56.9 mph (Exhibit 13-13)

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-26 EB*
Agency or Company	*Atkins*	From/To	*1145-Dorches Off to Dorches On*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2018 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*4688*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*4*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.980*

Speed Inputs			Calc Speed Adj and FFS		
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f_{LW}		mph
Number of Lanes, N	*3*		f_{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	*60.0*	mph	FFS	*60.0*	mph
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures			Design (N)	
Operational (LOS)			Design (N)	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1771*	pc/h/ln	Design LOS	
			v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h/ln
S	*59.5*	mph	S	mph
D = v_p / S	*29.8*	pc/mi/ln	D = v_p / S	pc/mi/ln
LOS	*D*		Required Number of Lanes, N	

Glossary		Factor Location	
N - Number of lanes	S - Speed	E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
V - Hourly volume	D - Density	E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 11-18	TRD - Page 11-11
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 11-2, 11-3	
DDHV - Directional design hour volume			

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-26 EB*
Agency or Company	*Atkins*	From/To	*1145-Dorches Off to Dorches On*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*PM Peak*	Analysis Year	*2018 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*3663*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*3*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.985*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*3*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*60.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*60.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1377*	pc/h/ln
S	*60.0*	mph
D = v_p / S	*23.0*	pc/mi/ln
LOS	*C*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-26 EB
Agency or Company	Atkins	Junction	1150 - EB On from Dorchester
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2018 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Number of Lanes, N: 3	☑ Yes ☐ On
☑ No ☐ Off	Acceleration Lane Length, L_A: 560	☐ No ☑ Off
L_{up} = ft	Deceleration Lane Length L_D:	L_{down} = 2100 ft
V_u = veh/h	Freeway Volume, V_F: 4688	V_D = 0 veh/h
	Ramp Volume, V_R: 651	
	Freeway Free-Flow Speed, S_{FF}: 60.0	
	Ramp Free-Flow Speed, S_{FR}: 45.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	4688	0.90	Level	4	0	0.980	1.00	5313
Ramp	651	0.90	Level	10	0	0.952	1.00	760
UpStream								
DownStream	0	0.90	Level	0	0	1.000	1.00	0

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = 0.00 (Equation 13-6 or 13-7)

P_{FM} = 0.593 using Equation (Exhibit 13-6)

V_{12} = 3152 pc/h

V_3 or V_{av34} 2161 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * $V_{12}/2$ ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	6073	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	3912	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = 32.1 (pc/mi/ln)

LOS = D (Exhibit 13-2)

Speed Determination

M_S = 0.466 (Exibit 13-11)

S_R= 51.6 mph (Exhibit 13-11)

S_0= 54.0 mph (Exhibit 13-11)

S = 52.4 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * $V_{12}/2$ ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-26 EB
Agency or Company	Atkins	Junction	1150 - EB On from Dorchester
Date Performed	4/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2018 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Number of Lanes, N: 3	☑ Yes ☐ On
☑ No ☐ Off	Acceleration Lane Length, L_A: 560	☐ No ☑ Off
L_{up} = ft	Deceleration Lane Length L_D:	L_{down} = 2100 ft
V_u = veh/h	Freeway Volume, V_F: 3663	V_D = 0 veh/h
	Ramp Volume, V_R: 508	
	Freeway Free-Flow Speed, S_{FF}: 60.0	
	Ramp Free-Flow Speed, S_{FR}: 45.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	3663	0.90	Level	3	0	0.985	1.00	4131
Ramp	508	0.90	Level	11	0	0.948	1.00	595
UpStream								
DownStream	0	0.90	Level	0	0	1.000	1.00	0

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = 0.00 (Equation 13-6 or 13-7)

P_{FM} = 0.593 using Equation (Exhibit 13-6)

V_{12} = 2450 pc/h

V_3 or V_{av34} 1681 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * $V_{12}/2$ ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	4726	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	3045	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = 25.4 (pc/mi/ln)

LOS = C (Exhibit 13-2)

Speed Determination

M_S = 0.353 (Exibit 13-11)

S_R= 53.7 mph (Exhibit 13-11)

S_0= 55.7 mph (Exhibit 13-11)

S = 54.4 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * $V_{12}/2$ ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-26 EB
Agency or Company	Atkins	Junction	1160-EB Off to Cosgrove SB
Date Performed	3/20/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2018 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp

☑ Yes ☑ On

☐ No ☐ Off

L_{up} = 2100 ft

V_u = 651 veh/h

Freeway Number of Lanes, N	3
Ramp Number of Lanes, N	1
Acceleration Lane Length, L_A	
Deceleration Lane Length L_D	200
Freeway Volume, V_F	5339
Ramp Volume, V_R	800
Freeway Free-Flow Speed, S_{FF}	60.0
Ramp Free-Flow Speed, S_{FR}	45.0

Downstream Adj Ramp

☐ Yes ☐ On

☑ No ☐ Off

L_{down} = ft

V_D = veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	5339	0.90	Level	4	0	0.980	1.00	6051
Ramp	800	0.90	Level	11	0	0.948	1.00	938
UpStream	651	0.90	Level	10	0	0.952	1.00	760
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = 5472.15 (Equation 13-12 or 13-13)

P_{FD} = 0.566 using Equation (Exhibit 13-7)

V_{12} = 3830 pc/h

V_3 or V_{av34} 2221 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	6051	Exhibit 13-8	6900	No
$V_{FO} = V_F - V_R$	5113	Exhibit 13-8	6900	No
V_R	938	Exhibit 13-10	2100	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	3830	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = 35.4 (pc/mi/ln)

LOS = E (Exhibit 13-2)

Speed Determination

D_s = 0.382 (Exhibit 13-12)

S_R= 53.1 mph (Exhibit 13-12)

S_0= 61.1 mph (Exhibit 13-12)

S = 55.8 mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-26 EB
Agency or Company	Atkins	Junction	1160-EB Off to Cosgrove SB
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2018 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp

☑ Yes ☑ On

☐ No ☐ Off

L_{up} = 2100 ft

V_u = 508 veh/h

Freeway Number of Lanes, N	3
Ramp Number of Lanes, N	1
Acceleration Lane Length, L_A	
Deceleration Lane Length L_D	200
Freeway Volume, V_F	4171
Ramp Volume, V_R	1160
Freeway Free-Flow Speed, S_{FF}	60.0
Ramp Free-Flow Speed, S_{FR}	45.0

Downstream Adj Ramp

☐ Yes ☐ On

☑ No ☐ Off

L_{down} = ft

V_D = veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	4171	0.90	Level	3	0	0.985	1.00	4704
Ramp	1160	0.90	Level	7	0	0.966	1.00	1334
UpStream	508	0.90	Level	11	0	0.948	1.00	595
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = 7647.03 (Equation 13-12 or 13-13)

P_{FD} = 0.581 using Equation (Exhibit 13-7)

V_{12} = 3292 pc/h

V_3 or V_{av34} 1412 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	4704	Exhibit 13-8	6900	No
$V_{FO} = V_F - V_R$	3370	Exhibit 13-8	6900	No
V_R	1334	Exhibit 13-10	2100	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	3292	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = 30.8 (pc/mi/ln)

LOS = D (Exhibit 13-2)

Speed Determination

D_s = 0.418 (Exhibit 13-12)

S_R= 52.5 mph (Exhibit 13-12)

S_0= 64.2 mph (Exhibit 13-12)

S = 55.5 mph (Exhibit 13-13)

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-26 EB*
Agency or Company	*Atkins*	From/To	*1165-Cosg SB Off to Cosg SB On*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2018 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*4539*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*4*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.980*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*3*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*60.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*60.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1715*	pc/h/ln
S	*59.8*	mph
D = v_p / S	*28.7*	pc/mi/ln
LOS	*D*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-26 EB*
Agency or Company	*Atkins*	From/To	*1165-Cosg SB Off to Cosg SB On*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*PM Peak*	Analysis Year	*2018 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*3011*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*3*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.985*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*3*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*60.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*60.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1132*	pc/h/ln
S	*60.0*	mph
D = v_p / S	*18.9*	pc/mi/ln
LOS	*C*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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Navy Base ICTF

FREEWAY WEAVING WORKSHEET

General Information

Analyst	AJR
Agency/Company	Atkins
Date Performed	7/25/2014
Analysis Time Period	AM Peak

Site Information

Freeway/Dir of Travel	I-26 EB
Weaving Segment Location	1170 - Cosgrove SB to Cos. NB
Analysis Year	2018 No Action

Project Description *Navy Base ICTF*

Inputs

Weaving configuration	One-Sided	Segment type	Freeway
Weaving number of lanes, N	4	Freeway minimum speed, S_{MIN}	15
Weaving segment length, L_S	600ft	Freeway maximum capacity, C_{IFL}	2300
Freeway free-flow speed, FFS	60 mph	Terrain type	Level

Conversions to pc/h Under Base Conditions

	V (veh/h)	PHF	Truck (%)	RV (%)	E_T	E_R	f_{HV}	f_p	v (pc/h)
V_{FF}	4241	0.90	4	0	1.5	1.2	0.980	1.00	4806
V_{RF}	423	0.90	2	0	1.5	1.2	0.990	1.00	475
V_{FR}	298	0.90	8	0	1.5	1.2	0.962	1.00	344
V_{RR}	0	0.90	0	0	1.5	1.2	1.000	1.00	0
V_{NW}	4806							V =	5625
V_W	819								
VR	0.146								

Configuration Characteristics

Minimum maneuver lanes, N_{WL}	2 lc	Minimum weaving lane changes, LC_{MIN}	819 lc/h
Interchange density, ID	1.0 int/mi	Weaving lane changes, LC_W	1007 lc/h
Minimum RF lane changes, LC_{RF}	1 lc/pc	Non-weaving lane changes, LC_{NW}	545 lc/h
Minimum FR lane changes, LC_{FR}	1 lc/pc	Total lane changes, LC_{ALL}	1552 lc/h
Minimum RR lane changes, LC_{RR}	lc/pc	Non-weaving vehicle index, I_{NW}	288

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment flow rate, v	5625 pc/h	Weaving intensity factor, W	0.478
Weaving segment capacity, c_w	8004 veh/h	Weaving segment speed, S	47.1 mph
Weaving segment v/c ratio	0.689	Average weaving speed, S_W	45.4 mph
Weaving segment density, D	29.9 pc/mi/ln	Average non-weaving speed, S_{NW}	47.4 mph
Level of Service, LOS	D	Maximum weaving length, L_{MAX}	3988 ft

Notes

a. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments".
b. For volumes that exceed the weaving segment capacity, the level of service is "F".

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Navy Base ICTF

FREEWAY WEAVING WORKSHEET

General Information

Analyst	AJR
Agency/Company	Atkins
Date Performed	7/25/2014
Analysis Time Period	PM Peak

Site Information

Freeway/Dir of Travel	I-26 EB
Weaving Segment Location	1170 - Cosgrove SB to Cos. NB
Analysis Year	2018 No Action

Project Description *Navy Base ICTF*

Inputs

Weaving configuration	One-Sided	Segment type	Freeway
Weaving number of lanes, N	4	Freeway minimum speed, S_{MIN}	15
Weaving segment length, L_S	600ft	Freeway maximum capacity, C_{IFL}	2300
Freeway free-flow speed, FFS	60 mph	Terrain type	Level

Conversions to pc/h Under Base Conditions

	V (veh/h)	PHF	Truck (%)	RV (%)	E_T	E_R	f_{HV}	f_p	v (pc/h)
V_{FF}	2873	0.90	3	0	1.5	1.2	0.985	1.00	3240
V_{RF}	420	0.90	2	0	1.5	1.2	0.990	1.00	471
V_{FR}	138	0.90	14	0	1.5	1.2	0.935	1.00	164
V_{RR}	0	0.90	0	0	1.5	1.2	1.000	1.00	0
V_{NW}	3240							V =	3875
V_W	635								
VR	0.164								

Configuration Characteristics

Minimum maneuver lanes, N_{WL}	2 lc	Minimum weaving lane changes, LC_{MIN}	635 lc/h
Interchange density, ID	1.0 int/mi	Weaving lane changes, LC_W	823 lc/h
Minimum RF lane changes, LC_{RF}	1 lc/pc	Non-weaving lane changes, LC_{NW}	222 lc/h
Minimum FR lane changes, LC_{FR}	1 lc/pc	Total lane changes, LC_{ALL}	1045 lc/h
Minimum RR lane changes, LC_{RR}	lc/pc	Non-weaving vehicle index, I_{NW}	194

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment flow rate, v	3875 pc/h	Weaving intensity factor, W	0.350
Weaving segment capacity, c_w	7988 veh/h	Weaving segment speed, S	50.4 mph
Weaving segment v/c ratio	0.478	Average weaving speed, S_W	48.3 mph
Weaving segment density, D	19.2 pc/mi/ln	Average non-weaving speed, S_{NW}	50.8 mph
Level of Service, LOS	B	Maximum weaving length, L_{MAX}	4170 ft

Notes

a. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments".
b. For volumes that exceed the weaving segment capacity, the level of service is "F".

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-26 EB*
Agency or Company	*Atkins*	From/To	*1175-Cosg NB Off to Cosg NB On*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2018 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*4664*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*4*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.980*

Speed Inputs			Calc Speed Adj and FFS		
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f_{LW}		mph
Number of Lanes, N	*3*		f_{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	*60.0*	mph	FFS	*60.0*	mph
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures			Design (N)	
Operational (LOS)			Design (N)	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1762*	pc/h/ln	Design LOS	
			v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h/ln
S	*59.5*	mph	S	mph
D = v_p / S	*29.6*	pc/mi/ln	D = v_p / S	pc/mi/ln
LOS	*D*		Required Number of Lanes, N	

Glossary		Factor Location	
N - Number of lanes	S - Speed	E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
V - Hourly volume	D - Density	E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 11-18	TRD - Page 11-11
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 11-2, 11-3	
DDHV - Directional design hour volume			

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-26 EB*
Agency or Company	*Atkins*	From/To	*1175-Cosg NB Off to Cosg NB On*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*PM Peak*	Analysis Year	*2018 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*3293*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*3*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.985*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*3*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*60.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*60.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1238*	pc/h/ln
S	*60.0*	mph
D = v_p / S	*20.6*	pc/mi/ln
LOS	*C*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-26 EB
Agency or Company	Atkins	Junction	1180 - EB On from Cosgrove NB
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2018 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Number of Lanes, N: 3	☐ Yes ☐ On
☑ No ☐ Off	Acceleration Lane Length, L_A: 440	☑ No ☐ Off
L_{up} = ft	Deceleration Lane Length L_D	L_{down} = ft
V_u = veh/h	Freeway Volume, V_F: 4664	V_D = veh/h
	Ramp Volume, V_R: 849	
	Freeway Free-Flow Speed, S_{FF}: 60.0	
	Ramp Free-Flow Speed, S_{FR}: 45.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	4664	0.90	Level	4	0	0.980	1.00	5286
Ramp	849	0.90	Level	12	0	0.943	1.00	1000
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 0.590 using Equation (Exhibit 13-6)

V_{12} = 3118 pc/h

V_3 or V_{av34} 2168 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * $V_{12}/2$ ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	6286	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	4118	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = 34.4 (pc/mi/ln)

LOS = D (Exhibit 13-2)

Speed Determination

M_S = 0.521 (Exibit 13-11)

S_R= 50.6 mph (Exhibit 13-11)

S_0= 54.0 mph (Exhibit 13-11)

S = 51.7 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * $V_{12}/2$ ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-26 EB
Agency or Company	Atkins	Junction	1180 - EB On from Cosgrove NB
Date Performed	4/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2018 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Number of Lanes, N	3	Downstream Adj Ramp	
☐ Yes	☐ On	Acceleration Lane Length, L_A	440	☐ Yes	☐ On
☑ No	☐ Off	Deceleration Lane Length L_D		☑ No	☐ Off
L_{up} =	ft	Freeway Volume, V_F	3293	L_{down} =	ft
V_u =	veh/h	Ramp Volume, V_R	456	V_D =	veh/h
		Freeway Free-Flow Speed, S_{FF}	60.0		
		Ramp Free-Flow Speed, S_{FR}	45.0		

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	3293	0.90	Level	3	0	0.985	1.00	3714
Ramp	456	0.90	Level	19	0	0.913	1.00	555
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 0.590 using Equation (Exhibit 13-6)

V_{12} = 2191 pc/h

V_3 or V_{av34} 1523 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * $V_{12}/2$ ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	4269	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	2746	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = 23.9 (pc/mi/ln)

LOS = C (Exhibit 13-2)

Speed Determination

M_S = 0.342 (Exibit 13-11)

S_R= 53.8 mph (Exhibit 13-11)

S_0= 56.3 mph (Exhibit 13-11)

S = 54.7 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * $V_{12}/2$ ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-26 EB*
Agency or Company	*Atkins*	From/To	*1190 - Cosgrove to US-52*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2018 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*5513*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*3*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.985*

Speed Inputs			Calc Speed Adj and FFS		
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f_{LW}		mph
Number of Lanes, N	*3*		f_{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	*60.0*	mph	FFS	*60.0*	mph
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures			Design (N)	
Operational (LOS)			Design (N)	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*2072*	pc/h/ln	Design LOS	
S	*56.0*	mph	v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h/ln
D = v_p / S	*37.0*	pc/mi/ln	S	mph
LOS	*E*		D = v_p / S	pc/mi/ln
			Required Number of Lanes, N	

Glossary		Factor Location	
N - Number of lanes	S - Speed	E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
V - Hourly volume	D - Density	E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 11-18	TRD - Page 11-11
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 11-2, 11-3	
DDHV - Directional design hour volume			

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-26 EB*
Agency or Company	*Atkins*	From/To	*1190 - Cosgrove to US-52*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*PM Peak*	Analysis Year	*2018 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*3749*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*3*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.985*

Speed Inputs			Calc Speed Adj and FFS		
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f_{LW}		mph
Number of Lanes, N	*3*		f_{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	*60.0*	mph	FFS	*60.0*	mph
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures			Design (N)	
Operational (LOS)			Design (N)	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1409*	pc/h/ln	Design LOS	
			v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h/ln
S	*60.0*	mph	S	mph
D = v_p / S	*23.5*	pc/mi/ln	D = v_p / S	pc/mi/ln
LOS	*C*		Required Number of Lanes, N	

Glossary		Factor Location	
N - Number of lanes	S - Speed	E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
V - Hourly volume	D - Density	E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 11-18	TRD - Page 11-11
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 11-2, 11-3	
DDHV - Directional design hour volume			

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F-2702

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-26 EB
Agency or Company	Atkins	Junction	1200-EB Off to US-52 & PAR
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2018 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Number of Lanes, N: 3	☐ Yes ☐ On
☑ No ☐ Off	Acceleration Lane Length, L_A:	☑ No ☐ Off
L_{up} = ft	Deceleration Lane Length L_D: 340	L_{down} = ft
V_u = veh/h	Freeway Volume, V_F: 5513	V_D = veh/h
	Ramp Volume, V_R: 339	
	Freeway Free-Flow Speed, S_{FF}: 60.0	
	Ramp Free-Flow Speed, S_{FR}: 45.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	5513	0.90	Level	3	0	0.985	1.00	6217
Ramp	339	0.90	Level	21	0	0.905	1.00	416
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 0.585 using Equation (Exhibit 13-7)

V_{12} = 3812 pc/h

V_3 or V_{av34} 2405 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	6217	Exhibit 13-8	6900	No
$V_{FO} = V_F - V_R$	5801	Exhibit 13-8	6900	No
V_R	416	Exhibit 13-10	2100	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	3812	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = 34.0 (pc/mi/ln)

LOS = D (Exhibit 13-2)

Speed Determination

D_s = 0.335 (Exhibit 13-12)

S_R= 54.0 mph (Exhibit 13-12)

S_0= 60.3 mph (Exhibit 13-12)

S = 56.3 mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-26 EB
Agency or Company	Atkins	Junction	1200-EB Off to US-52
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2018 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Number of Lanes, N: 3	☐ Yes ☐ On
☑ No ☐ Off	Acceleration Lane Length, L_A	☑ No ☐ Off
L_{up} = ft	Deceleration Lane Length L_D: 340	L_{down} = ft
V_u = veh/h	Freeway Volume, V_F: 3749	V_D = veh/h
	Ramp Volume, V_R: 316	
	Freeway Free-Flow Speed, S_{FF}: 60.0	
	Ramp Free-Flow Speed, S_{FR}: 45.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	3749	0.90	Level	3	0	0.985	1.00	4228
Ramp	316	0.90	Level	19	0	0.913	1.00	384
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 0.637 using Equation (Exhibit 13-7)

V_{12} = 2831 pc/h

V_3 or V_{av34} 1397 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	4228	Exhibit 13-8	6900	No
$V_{FO} = V_F - V_R$	3844	Exhibit 13-8	6900	No
V_R	384	Exhibit 13-10	2100	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	2831	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = 25.5 (pc/mi/ln)

LOS = C (Exhibit 13-2)

Speed Determination

D_s = 0.333 (Exhibit 13-12)

S_R= 54.0 mph (Exhibit 13-12)

S_0= 64.3 mph (Exhibit 13-12)

S = 57.0 mph (Exhibit 13-13)

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-26 EB*
Agency or Company	*Atkins*	From/To	*1205 - PAR Off to PAR On*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2018 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*5174*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*4*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.980*

Speed Inputs			Calc Speed Adj and FFS		
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f_{LW}		mph
Number of Lanes, N	*3*		f_{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	*60.0*	mph	FFS	*60.0*	mph
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures			Design (N)	
Operational (LOS)			Design (N)	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1955*	pc/h/ln	Design LOS	
S	*57.7*	mph	v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h/ln
D = v_p / S	*33.9*	pc/mi/ln	S	mph
LOS	*D*		D = v_p / S	pc/mi/ln
			Required Number of Lanes, N	

Glossary		Factor Location	
N - Number of lanes	S - Speed	E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
V - Hourly volume	D - Density	E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 11-18	TRD - Page 11-11
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 11-2, 11-3	
DDHV - Directional design hour volume			

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F-2705

BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-26 EB*
Agency or Company	*Atkins*	From/To	*1205 - PAR Off to PAR On*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*PM Peak*	Analysis Year	*2018 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*3433*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*3*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.985*

Speed Inputs			Calc Speed Adj and FFS		
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f_{LW}		mph
Number of Lanes, N	*3*		f_{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	*60.0*	mph	FFS	*60.0*	mph
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures			Design (N)	
Operational (LOS)			Design (N)	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1291*	pc/h/ln	Design LOS	
			v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h/ln
S	*60.0*	mph	S	mph
D = v_p / S	*21.5*	pc/mi/ln	D = v_p / S	pc/mi/ln
LOS	*C*		Required Number of Lanes, N	

Glossary		Factor Location	
N - Number of lanes	S - Speed	E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
V - Hourly volume	D - Density	E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 11-18	TRD - Page 11-11
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 11-2, 11-3	
DDHV - Directional design hour volume			

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F-2706

RAMP ADD OR DROP LANE ANALYSIS (MAINLINE <55 MPH)

ATKINS

General Information

Date Performed:	3/20/2014	Freeway/Direction	EB US-52 & PAR Off Ramp
Analysis Year	2018 No Action	Junction	US-52 & PAR EB Ramp Split
Analysis Time Period:	AM Peak	Segment ID	1208
Project Description:	Navy Base ICTF		

Inputs

	Mainline Upstream Ramp	Mainline Downstream Ramp	Ramp
Number of Lanes, N	1	1	1
Free-Flow Speed, FFS (mph)	45	55	45
Volume, V (veh/h)	339	248	91
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	21%	29%	2%
%RVs, P_R	0%	0%	0%

Performance Measures

	Upstream of Off-Ramp	Downstream of Off-Ramp	Off-Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.90	0.87	0.99
Demand Flow Rate, v_p (pc/h/ln)	416	316	102
Capacity Flow Rate, c (pc/h/ln)	2,100	2,200	2,100
v/c ratio	0.20	0.14	0.05
Density, D_{MD} (pc/mi/ln)	7.3	5.5	1.8
LOS	A	A	A

Formulas and Reference Material

$$f_{HV} = \frac{1}{1+P_T(E_T-1)+P_R(E_R-1)}$$ HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P}$$ HCM 2010, Equation 11-2

$$D_{MD} = \frac{0.0175*v_f}{N}$$ HCM 2010, Equation 13-26

Ramp Roadways Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

Diverge LOS Thresholds

LOS	Density (pc/mi/ln)
A	≤10
B	>10-20
C	>20-28
D	>28-35
E	>35
F	v/c > 1

Source: HCM 2010, Exhibit 13-2

RAMP ADD OR DROP LANE ANALYSIS (MAINLINE <55 MPH)

ATKINS

General Information

Date Performed:	3/20/2014	Freeway/Direction	EB US-52 & PAR Off Ramp
Analysis Year	2018 No Action	Junction	US-52 & PAR EB Ramp Split
Analysis Time Period:	PM Peak	Segment ID	1208
Project Description:	Navy Base ICTF		

Inputs

	Mainline Upstream Ramp	Mainline Downstream Ramp	Ramp
Number of Lanes, N	1	1	1
Free-Flow Speed, FFS (mph)	45	55	45
Volume, V (veh/h)	316	279	37
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	19%	22%	2%
%RVs, P_R	0%	0%	0%

Performance Measures

	Upstream of Off-Ramp	Downstream of Off-Ramp	Off-Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.91	0.90	0.99
Demand Flow Rate, v_p (pc/h/ln)	384	344	42
Capacity Flow Rate, c (pc/h/ln)	2,100	2,200	2,100
v/c ratio	0.18	0.16	0.02
Density, D_{MD} (pc/mi/ln)	6.7	6.0	0.7
LOS	A	A	A

Formulas and Reference Material

$$f_{HV} = \frac{1}{1+P_T(E_T-1)+P_R(E_R-1)}$$ HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P}$$ HCM 2010, Equation 11-2

$$D_{MD} = \frac{0.0175*v_f}{N}$$ HCM 2010, Equation 13-26

Ramp Roadways Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

Diverge LOS Thresholds

LOS	Density (pc/mi/ln)
A	≤10
B	>10-20
C	>20-28
D	>28-35
E	>35
F	v/c > 1

Source: HCM 2010, Exhibit 13-2

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-26 EB
Agency or Company	Atkins	Junction	1210 - EB On from PAR
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2018 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Number of Lanes, N: 3	☐ Yes ☐ On
☑ No ☐ Off	Acceleration Lane Length, L_A: 1000	☑ No ☐ Off
L_{up} = ft	Deceleration Lane Length L_D:	L_{down} = ft
V_u = veh/h	Freeway Volume, V_F: 5174	V_D = veh/h
	Ramp Volume, V_R: 75	
	Freeway Free-Flow Speed, S_{FF}: 60.0	
	Ramp Free-Flow Speed, S_{FR}: 55.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	5174	0.90	Level	4	0	0.980	1.00	5864
Ramp	75	0.90	Level	2	0	0.990	1.00	84
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 0.605 using Equation (Exhibit 13-6)

V_{12} = 3551 pc/h

V_3 or V_{av34} 2313 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	5948	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	3635	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = 27.5 (pc/mi/ln)

LOS = C (Exhibit 13-2)

Speed Determination

M_S = 0.359 (Exibit 13-11)

S_R= 53.5 mph (Exhibit 13-11)

S_0= 53.4 mph (Exhibit 13-11)

S = 53.5 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-26 EB
Agency or Company	Atkins	Junction	1210 - EB On from PAR
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2018 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Number of Lanes, N: 3	☐ Yes ☐ On
☑ No ☐ Off	Acceleration Lane Length, L_A: 1000	☑ No ☐ Off
L_{up} = ft	Deceleration Lane Length L_D:	L_{down} = ft
V_u = veh/h	Freeway Volume, V_F: 3433	V_D = veh/h
	Ramp Volume, V_R: 134	
	Freeway Free-Flow Speed, S_{FF}: 60.0	
	Ramp Free-Flow Speed, S_{FR}: 55.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	3433	0.90	Level	3	0	0.985	1.00	3872
Ramp	134	0.90	Level	2	0	0.990	1.00	150
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 0.605 using Equation (Exhibit 13-6)

V_{12} = 2344 pc/h

V_3 or V_{av34} 1528 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * $V_{12}/2$ ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	4022	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	2494	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = 18.6 (pc/mi/ln)

LOS = B (Exhibit 13-2)

Speed Determination

M_S = 0.258 (Exibit 13-11)

S_R= 55.4 mph (Exhibit 13-11)

S_0= 56.3 mph (Exhibit 13-11)

S = 55.7 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * $V_{12}/2$ ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-26 EB*
Agency or Company	*Atkins*	From/To	*1220 - PAR to Heriot*
Date Performed	*4/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2018 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*5249*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*4*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.980*

Speed Inputs			Calc Speed Adj and FFS		
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f_{LW}		mph
Number of Lanes, N	*3*		f_{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	*60.0*	mph	FFS	*60.0*	mph
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures			Design (N)	
Operational (LOS)			Design (N)	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1983*	pc/h/ln	Design LOS	
			v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h/ln
S	*57.3*	mph	S	mph
D = v_p / S	*34.6*	pc/mi/ln	D = v_p / S	pc/mi/ln
LOS	*D*		Required Number of Lanes, N	

Glossary		Factor Location	
N - Number of lanes	S - Speed	E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
V - Hourly volume	D - Density	E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 11-18	TRD - Page 11-11
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 11-2, 11-3	
DDHV - Directional design hour volume			

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-26 EB*
Agency or Company	*Atkins*	From/To	*1220 - PAR to Heriot*
Date Performed	*4/25/2014*	Jurisdiction	
Analysis Time Period	*PM Peak*	Analysis Year	*2018 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*3567*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*3*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.985*

Speed Inputs			Calc Speed Adj and FFS		
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f_{LW}		mph
Number of Lanes, N	*3*		f_{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	*60.0*	mph	FFS	*60.0*	mph
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures			Design (N)	
Operational (LOS)			Design (N)	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1341*	pc/h/ln	Design LOS	
			v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h/ln
S	*60.0*	mph	S	mph
D = v_p / S	*22.4*	pc/mi/ln	D = v_p / S	pc/mi/ln
LOS	*C*		Required Number of Lanes, N	

Glossary		Factor Location	
N - Number of lanes	S - Speed	E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
V - Hourly volume	D - Density	E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 11-18	TRD - Page 11-11
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 11-2, 11-3	
DDHV - Directional design hour volume			

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F-2712

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-26 EB
Agency or Company	Atkins	Junction	1230-EB Off to Heriot St
Date Performed	3/20/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2018 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Number of Lanes, N	3	Downstream Adj Ramp	
☐ Yes	☐ On	Acceleration Lane Length, L_A		☑ Yes	☐ On
☑ No	☐ Off	Deceleration Lane Length L_D	200	☐ No	☑ Off
L_{up} =	ft	Freeway Volume, V_F	5249	L_{down} =	1400 ft
V_u =	veh/h	Ramp Volume, V_R	625	V_D =	754 veh/h
		Freeway Free-Flow Speed, S_{FF}	55.0		
		Ramp Free-Flow Speed, S_{FR}	45.0		

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	5249	0.90	Level	4	0	0.980	1.00	5949
Ramp	625	0.90	Level	3	0	0.985	1.00	705
UpStream								
DownStream	754	0.90	Level	8	0	0.962	1.00	871

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = 1246.36 (Equation 13-12 or 13-13)

P_{FD} = 0.579 using Equation (Exhibit 13-7)

V_{12} = 3740 pc/h

V_3 or V_{av34} 2209 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	5949	Exhibit 13-8	6750	No
$V_{FO} = V_F - V_R$	5244	Exhibit 13-8	6750	No
V_R	705	Exhibit 13-10	2100	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	3740	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = 34.6 (pc/mi/ln)

LOS = D (Exhibit 13-2)

Speed Determination

D_s = 0.361 (Exhibit 13-12)

S_R= 50.3 mph (Exhibit 13-12)

S_0= 55.6 mph (Exhibit 13-12)

S = 52.2 mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-26 EB
Agency or Company	Atkins	Junction	1230-EB Off to Heriot St
Date Performed	3/20/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2018 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Number of Lanes, N: 3	☑ Yes ☐ On
☑ No ☐ Off	Acceleration Lane Length, L_A	☐ No ☑ Off
L_{up} = ft	Deceleration Lane Length L_D: 200	L_{down} = 1400 ft
V_u = veh/h	Freeway Volume, V_F: 3567	V_D = 344 veh/h
	Ramp Volume, V_R: 445	
	Freeway Free-Flow Speed, S_{FF}: 55.0	
	Ramp Free-Flow Speed, S_{FR}: 45.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	3567	0.90	Level	3	0	0.985	1.00	4023
Ramp	445	0.90	Level	4	0	0.980	1.00	504
UpStream								
DownStream	344	0.90	Level	15	0	0.930	1.00	411

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * $V_{12}/2$ ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = 492.31 (Equation 13-12 or 13-13)

P_{FD} = 0.636 using Equation (Exhibit 13-7)

V_{12} = 2743 pc/h

V_3 or V_{av34} 1280 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * $V_{12}/2$ ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	4023	Exhibit 13-8	6750	No
$V_{FO} = V_F - V_R$	3519	Exhibit 13-8	6750	No
V_R	504	Exhibit 13-10	2100	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	2743	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = 26.0 (pc/mi/ln)

LOS = C (Exhibit 13-2)

Speed Determination

D_s = 0.343 (Exhibit 13-12)

S_R= 50.5 mph (Exhibit 13-12)

S_0= 59.2 mph (Exhibit 13-12)

S = 53.0 mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-26 EB
Agency or Company	Atkins	Junction	1240-EB Off to Mt. Pleasant St
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2018 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Number of Lanes, N	3	Downstream Adj Ramp	
☐ Yes	☐ On	Acceleration Lane Length, L_A		☐ Yes	☐ On
☑ No	☐ Off	Deceleration Lane Length L_D	175	☑ No	☐ Off
L_{up} =	ft	Freeway Volume, V_F	4624	L_{down} =	ft
V_u =	veh/h	Ramp Volume, V_R	754	V_D =	veh/h
		Freeway Free-Flow Speed, S_{FF}	55.0		
		Ramp Free-Flow Speed, S_{FR}	45.0		

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	4624	0.90	Level	4	0	0.980	1.00	5241
Ramp	754	0.90	Level	8	0	0.962	1.00	871
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 0.589 using Equation (Exhibit 13-7)

V_{12} = 3445 pc/h

V_3 or V_{av34} 1796 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	5241	Exhibit 13-8	6750	No
$V_{FO} = V_F - V_R$	4370	Exhibit 13-8	6750	No
V_R	871	Exhibit 13-10	2100	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	3445	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = 32.3 (pc/mi/ln)

LOS = D (Exhibit 13-2)

Speed Determination

D_s = 0.376 (Exhibit 13-12)

S_R= 50.1 mph (Exhibit 13-12)

S_0= 57.2 mph (Exhibit 13-12)

S = 52.3 mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-26 EB
Agency or Company	Atkins	Junction	1240-EB Off to Mt. Pleasant St
Date Performed	3/20/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2018 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Number of Lanes, N	3	Downstream Adj Ramp	
☐ Yes	☐ On	Acceleration Lane Length, L_A		☐ Yes	☐ On
☑ No	☐ Off	Deceleration Lane Length L_D	175	☑ No	☐ Off
L_{up} =	ft	Freeway Volume, V_F	3122	L_{down} =	ft
V_u =	veh/h	Ramp Volume, V_R	344	V_D =	veh/h
		Freeway Free-Flow Speed, S_{FF}	55.0		
		Ramp Free-Flow Speed, S_{FR}	45.0		

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	3122	0.90	Level	3	0	0.985	1.00	3521
Ramp	344	0.90	Level	15	0	0.930	1.00	411
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 0.653 using Equation (Exhibit 13-7)

V_{12} = 2442 pc/h

V_3 or V_{av34} 1079 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	3521	Exhibit 13-8	6750	No
$V_{FO} = V_F - V_R$	3110	Exhibit 13-8	6750	No
V_R	411	Exhibit 13-10	2100	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	2442	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = 23.7 (pc/mi/ln)

LOS = C (Exhibit 13-2)

Speed Determination

D_s = 0.335 (Exhibit 13-12)

S_R= 50.6 mph (Exhibit 13-12)

S_0= 60.0 mph (Exhibit 13-12)

S = 53.2 mph (Exhibit 13-13)

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FREEWAY RAMP ADD OR DROP LANE ANALYSIS

ATKINS

General Information

Date Performed:	7/25/2014	Freeway/Direction	I-26 EB
Analysis Year	2018 No Action	Junction	EB Off to US-17 NB
Analysis Time Period:	AM Peak	Segment ID	1250
Project Description:	Navy Base ICTF		

Inputs

	Freeway Upstream of Ramp	Freeway Downstream of Ramp	Ramp
Number of Lanes, N	3	2	1
Free-Flow Speed, FFS (mph)	55	55	55
Volume, V (veh/h)	3,870	2,537	1,333
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	3%	3%	2%
%RVs, P_R	0%	0%	0%

Performance Measures

	Freeway Upstream Ramp	Freeway Downstream Ramp	Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.99	0.99	0.99
Demand Flow Rate, v_p (pc/h/ln)	1,455	1,431	1,496
Capacity Flow Rate, c (pc/h/ln)	2,250	2,250	2,200
v/c ratio	0.65	0.64	0.68
Density, D_{MD} (pc/mi/ln)	25.5	25.0	26.2
LOS	C	C	C

Formulas and Reference Material

$$f_{HV} = \frac{1}{1 + P_T(E_T-1)+P_R(E_R-1)}$$ HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P}$$ HCM 2010, Equation 11-2

$$D_{MD} = \frac{0.0175*v_f}{N}$$ HCM 2010, Equation 13-26

Basic Freeway Segments Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
75	2,400
70	2,400
65	2,350
60	2,300
55	2,250

Source: HCM 2010, Exhibit 11-17

Ramp Roadways Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

Diverge LOS Thresholds

LOS	Density (pc/mi/ln)
A	≤10
B	>10-20
C	>20-28
D	>28-35
E	>35
F	v/c > 1

Source: HCM 2010, Exhibit 13-2

FREEWAY RAMP ADD OR DROP LANE ANALYSIS

ATKINS

General Information

Date Performed:	7/25/2014	Freeway/Direction	I-26 EB
Analysis Year	2018 No Action	Junction	EB Off to US-17 NB
Analysis Time Period:	PM Peak	Segment ID	1250
Project Description:	Navy Base ICTF		

Inputs

	Freeway Upstream of Ramp	Freeway Downstream of Ramp	Ramp
Number of Lanes, N	3	2	1
Free-Flow Speed, FFS (mph)	55	55	55
Volume, V (veh/h)	2,778	2,064	714
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	3%	3%	2%
%RVs, P_R	0%	0%	0%

Performance Measures

	Freeway Upstream Ramp	Freeway Downstream Ramp	Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.99	0.99	0.99
Demand Flow Rate, v_p (pc/h/ln)	1,044	1,164	801
Capacity Flow Rate, c (pc/h/ln)	2,250	2,250	2,200
v/c ratio	0.46	0.52	0.36
Density, D_{MD} (pc/mi/ln)	18.3	20.4	14.0
LOS	B	C	B

Formulas and Reference Material

$$f_{HV} = \frac{1}{1 + P_T(E_T-1)+P_R(E_R-1)}$$ HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P}$$ HCM 2010, Equation 11-2

$$D_{MD} = \frac{0.0175*v_f}{N}$$ HCM 2010, Equation 13-26

Basic Freeway Segments Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
75	2,400
70	2,400
65	2,350
60	2,300
55	2,250

Source: HCM 2010, Exhibit 11-17

Ramp Roadways Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

Diverge LOS Thresholds

LOS	Density (pc/mi/ln)
A	≤10
B	>10-20
C	>20-28
D	>28-35
E	>35
F	v/c > 1

Source: HCM 2010, Exhibit 13-2

BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-26 EB*
Agency or Company	*Atkins*	From/To	*1260 - US17 NB to Cypress St*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2018 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*2537*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*3*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.985*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*55.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*55.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1431*	pc/h/ln
S	*55.0*	mph
D = v_p / S	*26.0*	pc/mi/ln
LOS	*D*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-26 EB*
Agency or Company	*Atkins*	From/To	*1260 - US17 NB to Cypress St*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*PM Peak*	Analysis Year	*2018 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*2064*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*3*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.985*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*55.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*55.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1164*	pc/h/ln
S	*55.0*	mph
D = v_p / S	*21.2*	pc/mi/ln
LOS	*C*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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FREEWAY RAMP ADD OR DROP LANE ANALYSIS

ATKINS

General Information

Date Performed:	7/25/2014	Freeway/Direction	I-26 EB
Analysis Year	2018 No Action	Junction	EB On from Cypress St
Analysis Time Period:	AM Peak	Segment ID	1270
Project Description:	Navy Base ICTF		

Inputs

	Freeway Upstream of Ramp	Freeway Downstream of Ramp	Ramp
Number of Lanes, N	2	3	1
Free-Flow Speed, FFS (mph)	55	55	45
Volume, V (veh/h)	2,537	2,623	86
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	3%	3%	21%
%RVs, P_R	0%	0%	0%

Performance Measures

	Freeway Upstream Ramp	Freeway Downstream Ramp	Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.99	0.99	0.90
Demand Flow Rate, v_p (pc/h/ln)	1,431	986	106
Capacity Flow Rate, c (pc/h/ln)	2,250	2,250	2,100
v/c ratio	0.64	0.44	0.05
Density, D_{MD} (pc/mi/ln)	25.0	17.3	1.9
LOS	C	B	A

Formulas and Reference Material

$$f_{HV} = \frac{1}{1 + P_T(E_T-1)+P_R(E_R-1)}$$ HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P}$$ HCM 2010, Equation 11-2

$$D_{MD} = \frac{0.0175*v_f}{N}$$ HCM 2010, Equation 13-26

Basic Freeway Segments Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
75	2,400
70	2,400
65	2,350
60	2,300
55	2,250

Source: HCM 2010, Exhibit 11-17

Ramp Roadways Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

Diverge LOS Thresholds

LOS	Density (pc/mi/ln)
A	≤10
B	>10-20
C	>20-28
D	>28-35
E	>35
F	v/c > 1

Source: HCM 2010, Exhibit 13-2

FREEWAY RAMP ADD OR DROP LANE ANALYSIS

ATKINS

General Information

Date Performed:	7/25/2014	Freeway/Direction	I-26 EB
Analysis Year	2018 No Action	Junction	EB On from Cypress St
Analysis Time Period:	PM Peak	Segment ID	1270
Project Description:	Navy Base ICTF		

Inputs

	Freeway Upstream of Ramp	Freeway Downstream of Ramp	Ramp
Number of Lanes, N	2	3	1
Free-Flow Speed, FFS (mph)	55	55	45
Volume, V (veh/h)	2,064	2,209	145
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	3%	3%	10%
%RVs, P_R	0%	0%	0%

Performance Measures

	Freeway Upstream Ramp	Freeway Downstream Ramp	Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.99	0.99	0.95
Demand Flow Rate, v_p (pc/h/ln)	1,164	830	169
Capacity Flow Rate, c (pc/h/ln)	2,250	2,250	2,100
v/c ratio	0.52	0.37	0.08
Density, D_{MD} (pc/mi/ln)	20.4	14.5	3.0
LOS	C	B	A

Formulas and Reference Material

$$f_{HV} = \frac{1}{1 + P_T(E_T-1)+P_R(E_R-1)}$$ HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P}$$ HCM 2010, Equation 11-2

$$D_{MD} = \frac{0.0175*v_f}{N}$$ HCM 2010, Equation 13-26

Basic Freeway Segments Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
75	2,400
70	2,400
65	2,350
60	2,300
55	2,250

Source: HCM 2010, Exhibit 11-17

Ramp Roadways Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

Diverge LOS Thresholds

LOS	Density (pc/mi/ln)
A	≤10
B	>10-20
C	>20-28
D	>28-35
E	>35
F	v/c > 1

Source: HCM 2010, Exhibit 13-2

BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-26 EB*
Agency or Company	*Atkins*	From/To	*1280 - East Of Cypress*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2018 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*2623*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*3*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.985*

Speed Inputs			Calc Speed Adj and FFS		
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f_{LW}		mph
Number of Lanes, N	*3*		f_{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	*55.0*	mph	FFS	*55.0*	mph
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures			Design (N)	
Operational (LOS)			Design (N)	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*986*	pc/h/ln	Design LOS	
S	*55.0*	mph	v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h/ln
D = v_p / S	*17.9*	pc/mi/ln	S	mph
LOS	*B*		D = v_p / S	pc/mi/ln
			Required Number of Lanes, N	

Glossary		Factor Location	
N - Number of lanes	S - Speed	E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
V - Hourly volume	D - Density	E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 11-18	TRD - Page 11-11
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 11-2, 11-3	
DDHV - Directional design hour volume			

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-26 EB*
Agency or Company	*Atkins*	From/To	*1280 - East Of Cypress*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*PM Peak*	Analysis Year	*2018 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*2209*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*3*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length	*mi*
			Up/Down %	

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.985*

Speed Inputs			Calc Speed Adj and FFS		
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f_{LW}		mph
Number of Lanes, N	*3*		f_{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	*55.0*	mph	FFS	*55.0*	mph
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures			Design (N)	
Operational (LOS)			Design (N)	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*830*	pc/h/ln	Design LOS	
			v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h/ln
S	*55.0*	mph	S	mph
D = v_p / S	*15.1*	pc/mi/ln	D = v_p / S	pc/mi/ln
LOS	*B*		Required Number of Lanes, N	

Glossary		Factor Location	
N - Number of lanes	S - Speed	E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
V - Hourly volume	D - Density	E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 11-18	TRD - Page 11-11
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 11-2, 11-3	
DDHV - Directional design hour volume			

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FREEWAY RAMP ADD OR DROP LANE ANALYSIS

ATKINS

General Information

Date Performed:	7/25/2014	Freeway/Direction	I-26 WB
Analysis Year	2018 No Action	Junction	WB Off to US-17 NB
Analysis Time Period:	AM Peak	Segment ID	2010
Project Description:	Navy Base ICTF		

Inputs

	Freeway Upstream of Ramp	Freeway Downstream of Ramp	Ramp
Number of Lanes, N	4	3	2
Free-Flow Speed, FFS (mph)	55	55	55
Volume, V (veh/h)	3,389	1,398	1,991
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	3%	4%	2%
%RVs, P_R	0%	0%	0%

Performance Measures

	Freeway Upstream Ramp	Freeway Downstream Ramp	Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.99	0.98	0.99
Demand Flow Rate, v_p (pc/h/ln)	956	528	1,117
Capacity Flow Rate, c (pc/h/ln)	2,250	2,250	2,200
v/c ratio	0.42	0.23	0.51
Density, D_{MD} (pc/mi/ln)	16.7	9.2	19.5
LOS	B	A	B

Formulas and Reference Material

$$f_{HV} = \frac{1}{1 + P_T(E_T-1)+P_R(E_R-1)}$$ HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P}$$ HCM 2010, Equation 11-2

$$D_{MD} = \frac{0.0175*v_f}{N}$$ HCM 2010, Equation 13-26

Basic Freeway Segments Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
75	2,400
70	2,400
65	2,350
60	2,300
55	2,250

Source: HCM 2010, Exhibit 11-17

Ramp Roadways Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

Diverge LOS Thresholds

LOS	Density (pc/mi/ln)
A	≤10
B	>10-20
C	>20-28
D	>28-35
E	>35
F	v/c > 1

Source: HCM 2010, Exhibit 13-2

FREEWAY RAMP ADD OR DROP LANE ANALYSIS

ATKINS

General Information

Date Performed:	7/25/2014	Freeway/Direction	I-26 WB
Analysis Year	2018 No Action	Junction	WB Off to US-17 NB
Analysis Time Period:	PM Peak	Segment ID	2010
Project Description:	Navy Base ICTF		

Inputs

	Freeway Upstream of Ramp	Freeway Downstream of Ramp	Ramp
Number of Lanes, N	4	3	2
Free-Flow Speed, FFS (mph)	55	55	55
Volume, V (veh/h)	4,228	2,029	2,199
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	3%	3%	2%
%RVs, P_R	0%	0%	0%

Performance Measures

	Freeway Upstream Ramp	Freeway Downstream Ramp	Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.99	0.99	0.99
Demand Flow Rate, v_p (pc/h/ln)	1,192	763	1,234
Capacity Flow Rate, c (pc/h/ln)	2,250	2,250	2,200
v/c ratio	0.53	0.34	0.56
Density, D_{MD} (pc/mi/ln)	20.9	13.4	21.6
LOS	C	B	C

Formulas and Reference Material

$$f_{HV} = \frac{1}{1 + P_T(E_T-1)+P_R(E_R-1)}$$

HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P}$$

HCM 2010, Equation 11-2

$$D_{MD} = \frac{0.0175*v_f}{N}$$

HCM 2010, Equation 13-26

Basic Freeway Segments Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
75	2,400
70	2,400
65	2,350
60	2,300
55	2,250

Source: HCM 2010, Exhibit 11-17

Ramp Roadways Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

Diverge LOS Thresholds

LOS	Density (pc/mi/ln)
A	≤10
B	>10-20
C	>20-28
D	>28-35
E	>35
F	v/c > 1

Source: HCM 2010, Exhibit 13-2

FREEWAY RAMP ADD OR DROP LANE ANALYSIS

ATKINS

General Information

Date Performed:	3/20/2014	Freeway/Direction	I-26 WB
Analysis Year	2018 No Action	Junction	WB Off to Romney St
Analysis Time Period:	AM Peak	Segment ID	2020
Project Description:	Navy Base ICTF		

Inputs

	Freeway Upstream of Ramp	Freeway Downstream of Ramp	Ramp
Number of Lanes, N	3	2	1
Free-Flow Speed, FFS (mph)	55	55	45
Volume, V (veh/h)	1,398	1,189	209
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	4%	4%	5%
%RVs, P_R	0%	0%	0%

Performance Measures

	Freeway Upstream Ramp	Freeway Downstream Ramp	Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.98	0.98	0.98
Demand Flow Rate, v_p (pc/h/ln)	528	674	238
Capacity Flow Rate, c (pc/h/ln)	2,250	2,250	2,100
v/c ratio	0.23	0.30	0.11
Density, D_{MD} (pc/mi/ln)	9.2	11.8	4.2
LOS	A	B	A

Formulas and Reference Material

$$f_{HV} = \frac{1}{1 + P_T(E_T-1)+P_R(E_R-1)}$$ HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P}$$ HCM 2010, Equation 11-2

$$D_{MD} = \frac{0.0175*v_f}{N}$$ HCM 2010, Equation 13-26

Basic Freeway Segments Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
75	2,400
70	2,400
65	2,350
60	2,300
55	2,250

Source: HCM 2010, Exhibit 11-17

Ramp Roadways Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

Diverge LOS Thresholds

LOS	Density (pc/mi/ln)
A	≤10
B	>10-20
C	>20-28
D	>28-35
E	>35
F	v/c > 1

Source: HCM 2010, Exhibit 13-2

FREEWAY RAMP ADD OR DROP LANE ANALYSIS

ATKINS

General Information

Date Performed:	7/25/2014	Freeway/Direction	I-26 WB
Analysis Year	2018 No Action	Junction	WB Off to Romney St
Analysis Time Period:	PM Peak	Segment ID	2020
Project Description:	Navy Base ICTF		

Inputs

	Freeway Upstream of Ramp	Freeway Downstream of Ramp	Ramp
Number of Lanes, N	3	2	1
Free-Flow Speed, FFS (mph)	55	55	45
Volume, V (veh/h)	2,029	1,892	137
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	3%	3%	6%
%RVs, P_R	0%	0%	0%

Performance Measures

	Freeway Upstream Ramp	Freeway Downstream Ramp	Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.99	0.99	0.97
Demand Flow Rate, v_p (pc/h/ln)	763	1,067	157
Capacity Flow Rate, c (pc/h/ln)	2,250	2,250	2,100
v/c ratio	0.34	0.47	0.07
Density, D_{MD} (pc/mi/ln)	13.4	18.7	2.7
LOS	B	B	A

Formulas and Reference Material

$$f_{HV} = \frac{1}{1 + P_T(E_T-1)+P_R(E_R-1)}$$ HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P}$$ HCM 2010, Equation 11-2

$$D_{MD} = \frac{0.0175*v_f}{N}$$ HCM 2010, Equation 13-26

Basic Freeway Segments Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
75	2,400
70	2,400
65	2,350
60	2,300
55	2,250

Source: HCM 2010, Exhibit 11-17

Ramp Roadways Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

Diverge LOS Thresholds

LOS	Density (pc/mi/ln)
A	≤10
B	>10-20
C	>20-28
D	>28-35
E	>35
F	v/c > 1

Source: HCM 2010, Exhibit 13-2

BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-26 WB*
Agency or Company	*Atkins*	From/To	*2025- Romney Off to US17 SB On*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2018 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*1189*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*4*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.980*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*55.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*55.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*674*	pc/h/ln
S	*55.0*	mph
D = v_p / S	*12.3*	pc/mi/ln
LOS	*B*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-26 WB*
Agency or Company	*Atkins*	From/To	*2025- Romney Off to US17 SB On*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*PM Peak*	Analysis Year	*2018 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*1892*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*3*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.985*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*55.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*55.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1067*	pc/h/ln
S	*55.0*	mph
D = v_p / S	*19.4*	pc/mi/ln
LOS	*C*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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FREEWAY RAMP ADD OR DROP LANE ANALYSIS

ATKINS

General Information

Date Performed:	7/25/2014	Freeway/Direction	I-26 WB
Analysis Year	2018 No Action	Junction	WB On from US-17 SB
Analysis Time Period:	AM Peak	Segment ID	2030
Project Description:	Navy Base ICTF		

Inputs

	Freeway Upstream of Ramp	Freeway Downstream of Ramp	Ramp
Number of Lanes, N	2	3	1
Free-Flow Speed, FFS (mph)	55	55	55
Volume, V (veh/h)	1,189	2,386	1,197
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	4%	3%	2%
%RVs, P_R	0%	0%	0%

Performance Measures

	Freeway Upstream Ramp	Freeway Downstream Ramp	Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.98	0.99	0.99
Demand Flow Rate, v_p (pc/h/ln)	674	897	1,343
Capacity Flow Rate, c (pc/h/ln)	2,250	2,250	2,200
v/c ratio	0.30	0.40	0.61
Density, D_{MD} (pc/mi/ln)	11.8	15.7	23.5
LOS	B	B	C

Formulas and Reference Material

$$f_{HV} = \frac{1}{1 + P_T(E_T-1)+P_R(E_R-1)}$$ HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P}$$ HCM 2010, Equation 11-2

$$D_{MD} = \frac{0.0175*v_f}{N}$$ HCM 2010, Equation 13-26

Basic Freeway Segments Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
75	2,400
70	2,400
65	2,350
60	2,300
55	2,250

Source: HCM 2010, Exhibit 11-17

Ramp Roadways Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

Diverge LOS Thresholds

LOS	Density (pc/mi/ln)
A	≤10
B	>10-20
C	>20-28
D	>28-35
E	>35
F	v/c > 1

Source: HCM 2010, Exhibit 13-2

FREEWAY RAMP ADD OR DROP LANE ANALYSIS

ATKINS

General Information

Date Performed:	7/25/2014	Freeway/Direction	I-26 WB
Analysis Year	2018 No Action	Junction	WB On from US-17 SB
Analysis Time Period:	PM Peak	Segment ID	2030
Project Description:	Navy Base ICTF		

Inputs

	Freeway Upstream of Ramp	Freeway Downstream of Ramp	Ramp
Number of Lanes, N	2	3	1
Free-Flow Speed, FFS (mph)	55	55	55
Volume, V (veh/h)	1,892	3,092	1,200
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	3%	3%	2%
%RVs, P_R	0%	0%	0%

Performance Measures

	Freeway Upstream Ramp	Freeway Downstream Ramp	Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.99	0.99	0.99
Demand Flow Rate, v_p (pc/h/ln)	1,067	1,162	1,347
Capacity Flow Rate, c (pc/h/ln)	2,250	2,250	2,200
v/c ratio	0.47	0.52	0.61
Density, D_{MD} (pc/mi/ln)	18.7	20.3	23.6
LOS	B	C	C

Formulas and Reference Material

$$f_{HV} = \frac{1}{1 + P_T(E_T-1)+P_R(E_R-1)}$$ HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P}$$ HCM 2010, Equation 11-2

$$D_{MD} = \frac{0.0175*v_f}{N}$$ HCM 2010, Equation 13-26

Basic Freeway Segments Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
75	2,400
70	2,400
65	2,350
60	2,300
55	2,250

Source: HCM 2010, Exhibit 11-17

Ramp Roadways Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

Diverge LOS Thresholds

LOS	Density (pc/mi/ln)
A	≤10
B	>10-20
C	>20-28
D	>28-35
E	>35
F	v/c > 1

Source: HCM 2010, Exhibit 13-2

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-26 WB
Agency or Company	Atkins	Junction	2040 - WB On from Meeting
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2018 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Number of Lanes, N: 3	☐ Yes ☐ On
☑ No ☐ Off	Acceleration Lane Length, L_A: 600	☑ No ☐ Off
L_{up} = ft	Deceleration Lane Length L_D:	L_{down} = ft
V_u = veh/h	Freeway Volume, V_F: 2386	V_D = veh/h
	Ramp Volume, V_R: 367	
	Freeway Free-Flow Speed, S_{FF}: 55.0	
	Ramp Free-Flow Speed, S_{FR}: 45.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	2386	0.90	Level	3	0	0.985	1.00	2691
Ramp	367	0.90	Level	7	0	0.966	1.00	422
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 0.594 using Equation (Exhibit 13-6)

V_{12} = 1599 pc/h

V_3 or V_{av34} 1092 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	3113	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	2021	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = 17.3 (pc/mi/ln)

LOS = B (Exhibit 13-2)

Speed Determination

M_S = 0.296 (Exibit 13-11)

S_R= 51.1 mph (Exhibit 13-11)

S_0= 52.9 mph (Exhibit 13-11)

S = 51.7 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-26 WB
Agency or Company	Atkins	Junction	2040 - WB On from Meeting
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2018 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Number of Lanes, N: 3	☐ Yes ☐ On
☑ No ☐ Off	Acceleration Lane Length, L_A: 600	☑ No ☐ Off
L_{up} = ft	Deceleration Lane Length L_D:	L_{down} = ft
V_u = veh/h	Freeway Volume, V_F: 3092	V_D = veh/h
	Ramp Volume, V_R: 727	
	Freeway Free-Flow Speed, S_{FF}: 55.0	
	Ramp Free-Flow Speed, S_{FR}: 45.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	3092	0.90	Level	3	0	0.985	1.00	3487
Ramp	727	0.90	Level	3	0	0.985	1.00	820
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 0.594 using Equation (Exhibit 13-6)

V_{12} = 2072 pc/h

V_3 or V_{av34} 1415 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	4307	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	2892	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = 23.9 (pc/mi/ln)

LOS = C (Exhibit 13-2)

Speed Determination

M_S = 0.337 (Exibit 13-11)

S_R= 50.6 mph (Exhibit 13-11)

S_0= 51.7 mph (Exhibit 13-11)

S = 51.0 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-26 WB*
Agency or Company	*Atkins*	From/To	*2050 - Meeting to Mt Pleasant*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2018 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*2753*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*3*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.985*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*3*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*55.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*55.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1035*	pc/h/ln
S	*55.0*	mph
D = v_p / S	*18.8*	pc/mi/ln
LOS	*C*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-26 WB*
Agency or Company	*Atkins*	From/To	*2050 - Meeting to Mt Pleasant*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*PM Peak*	Analysis Year	*2018 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*3819*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*3*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.985*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*3*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*55.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*55.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1436*	pc/h/ln
S	*55.0*	mph
D = v_p / S	*26.1*	pc/mi/ln
LOS	*D*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-26 WB
Agency or Company	Atkins	Junction	2060 - WB On from Mt Pleasant
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2018 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Freeway Number of Lanes, N: 3	☐ Yes ☐ On
☑ No ☐ Off	Ramp Number of Lanes, N: 1	☑ No ☐ Off
L_{up} = ft	Acceleration Lane Length, L_A: 275	L_{down} = ft
V_u = veh/h	Deceleration Lane Length L_D	V_D = veh/h
	Freeway Volume, V_F: 2753	
	Ramp Volume, V_R: 298	
	Freeway Free-Flow Speed, S_{FF}: 55.0	
	Ramp Free-Flow Speed, S_{FR}: 45.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	2753	0.90	Level	3	0	0.985	1.00	3105
Ramp	298	0.90	Level	5	0	0.976	1.00	339
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 0.585 using Equation (Exhibit 13-6)

V_{12} = 1817 pc/h

V_3 or V_{av34} 1288 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * $V_{12}/2$ ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	3444	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	2156	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = 20.4 (pc/mi/ln)

LOS = C (Exhibit 13-2)

Speed Determination

M_S = 0.330 (Exibit 13-11)

S_R= 50.7 mph (Exhibit 13-11)

S_0= 52.2 mph (Exhibit 13-11)

S = 51.2 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * $V_{12}/2$ ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-26 WB
Agency or Company	Atkins	Junction	2060 - WB On from Mt Pleasant
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2018 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Freeway Number of Lanes, N: 3	☐ Yes ☐ On
☑ No ☐ Off	Ramp Number of Lanes, N: 1	☑ No ☐ Off
L_{up} = ft	Acceleration Lane Length, L_A: 275	L_{down} = ft
V_u = veh/h	Deceleration Lane Length L_D:	V_D = veh/h
	Freeway Volume, V_F: 3819	
	Ramp Volume, V_R: 711	
	Freeway Free-Flow Speed, S_{FF}: 55.0	
	Ramp Free-Flow Speed, S_{FR}: 45.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	3819	0.90	Level	3	0	0.985	1.00	4307
Ramp	711	0.90	Level	2	0	0.990	1.00	798
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 0.585 using Equation (Exhibit 13-6)

V_{12} = 2520 pc/h

V_3 or V_{av34} 1787 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * $V_{12}/2$ ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	5105	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	3318	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = 29.3 (pc/mi/ln)

LOS = D (Exhibit 13-2)

Speed Determination

M_S = 0.404 (Exibit 13-11)

S_R= 49.7 mph (Exhibit 13-11)

S_0= 50.4 mph (Exhibit 13-11)

S = 50.0 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * $V_{12}/2$ ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-26 WB
Agency or Company	Atkins	Junction	2070 - WB On from Heriot
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2018 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Number of Lanes, N: 3	☐ Yes ☐ On
☑ No ☐ Off	Acceleration Lane Length, L_A: 1165	☑ No ☐ Off
L_{up} = ft	Deceleration Lane Length L_D:	L_{down} = ft
V_u = veh/h	Freeway Volume, V_F: 3051	V_D = veh/h
	Ramp Volume, V_R: 247	
	Freeway Free-Flow Speed, S_{FF}: 55.0	
	Ramp Free-Flow Speed, S_{FR}: 45.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	3051	0.90	Level	4	0	0.980	1.00	3458
Ramp	247	0.90	Level	20	0	0.909	1.00	302
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 0.610 using Equation (Exhibit 13-6)

V_{12} = 2110 pc/h

V_3 or V_{av34} 1348 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	3760	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	2412	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = 16.8 (pc/mi/ln)

LOS = B (Exhibit 13-2)

Speed Determination

M_S = 0.260 (Exibit 13-11)

S_R= 51.6 mph (Exhibit 13-11)

S_0= 51.9 mph (Exhibit 13-11)

S = 51.7 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-26 WB
Agency or Company	Atkins	Junction	2070 - WB On from Heriot
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2018 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Number of Lanes, N: 3	☐ Yes ☐ On
☑ No ☐ Off	Acceleration Lane Length, L_A: 1165	☑ No ☐ Off
L_{up} = ft	Deceleration Lane Length L_D:	L_{down} = ft
V_u = veh/h	Freeway Volume, V_F: 4530	V_D = veh/h
	Ramp Volume, V_R: 414	
	Freeway Free-Flow Speed, S_{FF}: 55.0	
	Ramp Free-Flow Speed, S_{FR}: 45.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	4530	0.90	Level	3	0	0.985	1.00	5109
Ramp	414	0.90	Level	10	0	0.952	1.00	483
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 0.610 using Equation (Exhibit 13-6)

V_{12} = 3117 pc/h

V_3 or V_{av34} 1992 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	5592	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	3600	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = 26.0 (pc/mi/ln)

LOS = C (Exhibit 13-2)

Speed Determination

M_S = 0.359 (Exibit 13-11)

S_R= 50.3 mph (Exhibit 13-11)

S_0= 49.6 mph (Exhibit 13-11)

S = 50.1 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-26 WB*
Agency or Company	*Atkins*	From/To	*2080 - Heriot to PAR*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2018 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*3298*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*4*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.980*

Speed Inputs			Calc Speed Adj and FFS		
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f_{LW}		mph
Number of Lanes, N	*3*		f_{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	*60.0*	mph	FFS	*60.0*	mph
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures			Design (N)	
Operational (LOS)			Design (N)	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1246*	pc/h/ln	Design LOS	
S	*60.0*	mph	v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h/ln
D = v_p / S	*20.8*	pc/mi/ln	S	mph
LOS	*C*		D = v_p / S	pc/mi/ln
			Required Number of Lanes, N	

Glossary		Factor Location	
N - Number of lanes	S - Speed	E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
V - Hourly volume	D - Density	E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 11-18	TRD - Page 11-11
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 11-2, 11-3	
DDHV - Directional design hour volume			

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-26 WB*
Agency or Company	*Atkins*	From/To	*2080 - Heriot to PAR*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*PM Peak*	Analysis Year	*2018 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*4944*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*3*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.985*

Speed Inputs			Calc Speed Adj and FFS		
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f_{LW}		mph
Number of Lanes, N	*3*		f_{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	*60.0*	mph	FFS	*60.0*	mph
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures			Design (N)	
Operational (LOS)			Design (N)	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1859*	pc/h/ln	Design LOS	
			v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h/ln
S	*58.8*	mph	S	mph
D = v_p / S	*31.6*	pc/mi/ln	D = v_p / S	pc/mi/ln
LOS	*D*		Required Number of Lanes, N	

Glossary		Factor Location	
N - Number of lanes	S - Speed	E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
V - Hourly volume	D - Density	E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 11-18	TRD - Page 11-11
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 11-2, 11-3	
DDHV - Directional design hour volume			

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-26 WB
Agency or Company	Atkins	Junction	2090-WB Off to PAR
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2018 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Number of Lanes, N: 3	☐ Yes ☐ On
☑ No ☐ Off	Acceleration Lane Length, L_A	☑ No ☐ Off
L_{up} = ft	Deceleration Lane Length L_D: 340	L_{down} = ft
V_u = veh/h	Freeway Volume, V_F: 3298	V_D = veh/h
	Ramp Volume, V_R: 119	
	Freeway Free-Flow Speed, S_{FF}: 60.0	
	Ramp Free-Flow Speed, S_{FR}: 45.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	3298	0.90	Level	4	0	0.980	1.00	3738
Ramp	119	0.90	Level	2	0	0.990	1.00	134
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 0.660 using Equation (Exhibit 13-7)

V_{12} = 2514 pc/h

V_3 or V_{av34} 1224 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	3738	Exhibit 13-8	6900	No
$V_{FO} = V_F - V_R$	3604	Exhibit 13-8	6900	No
V_R	134	Exhibit 13-10	2100	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	2514	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = 22.8 (pc/mi/ln)

LOS = C (Exhibit 13-2)

Speed Determination

D_s = 0.310 (Exhibit 13-12)

S_R= 54.4 mph (Exhibit 13-12)

S_0= 64.9 mph (Exhibit 13-12)

S = 57.5 mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-26 WB
Agency or Company	Atkins	Junction	2090-WB Off to PAR
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2018 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Number of Lanes, N: 3	☐ Yes ☐ On
☑ No ☐ Off	Acceleration Lane Length, L_A:	☑ No ☐ Off
L_{up} = ft	Deceleration Lane Length L_D: 340	L_{down} = ft
V_u = veh/h	Freeway Volume, V_F: 4944	V_D = veh/h
	Ramp Volume, V_R: 78	
	Freeway Free-Flow Speed, S_{FF}: 60.0	
	Ramp Free-Flow Speed, S_{FR}: 45.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	4944	0.90	Level	3	0	0.985	1.00	5576
Ramp	78	0.90	Level	2	0	0.990	1.00	88
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 0.617 using Equation (Exhibit 13-7)

V_{12} = 3472 pc/h

V_3 or V_{av34} 2104 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	5576	Exhibit 13-8	6900	No
$V_{FO} = V_F - V_R$	5488	Exhibit 13-8	6900	No
V_R	88	Exhibit 13-10	2100	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	3472	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = 31.1 (pc/mi/ln)

LOS = D (Exhibit 13-2)

Speed Determination

D_s = 0.306 (Exhibit 13-12)

S_R= 54.5 mph (Exhibit 13-12)

S_0= 61.5 mph (Exhibit 13-12)

S = 56.9 mph (Exhibit 13-13)

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-26 WB*
Agency or Company	*Atkins*	From/To	*2100 - PAR Off to PAR On*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2018 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*3179*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*4*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.980*

Speed Inputs			Calc Speed Adj and FFS		
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f_{LW}		mph
Number of Lanes, N	*3*		f_{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	*60.0*	mph	FFS	*60.0*	mph
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures			Design (N)	
Operational (LOS)			Design (N)	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1201*	pc/h/ln	Design LOS	
			v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h/ln
S	*60.0*	mph	S	mph
D = v_p / S	*20.0*	pc/mi/ln	D = v_p / S	pc/mi/ln
LOS	*C*		Required Number of Lanes, N	

Glossary		Factor Location	
N - Number of lanes	S - Speed	E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
V - Hourly volume	D - Density	E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 11-18	TRD - Page 11-11
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 11-2, 11-3	
DDHV - Directional design hour volume			

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-26 WB*
Agency or Company	*Atkins*	From/To	*2100 - PAR Off to PAR On*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*PM Peak*	Analysis Year	*2018 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*4866*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*3*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.985*

Speed Inputs			Calc Speed Adj and FFS		
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f_{LW}		mph
Number of Lanes, N	*3*		f_{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	*60.0*	mph	FFS	*60.0*	mph
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures			Design (N)	
Operational (LOS)			Design (N)	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1829*	pc/h/ln	Design LOS	
S	*59.0*	mph	v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h/ln
D = v_p / S	*31.0*	pc/mi/ln	S	mph
LOS	*D*		D = v_p / S	pc/mi/ln
			Required Number of Lanes, N	

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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RAMP ADD OR DROP LANE ANALYSIS (MAINLINE <55 MPH)

ATKINS

General Information

Date Performed:	3/20/2014	Freeway/Direction	WB US-52 & PAR Off Ramp
Analysis Year	2018 No Action	Junction	US-52 & PAR WB Ramp Merge
Analysis Time Period:	AM Peak	Segment ID	2105
Project Description:	Navy Base ICTF		

Inputs

	Mainline Upstream Ramp	Mainline Downstream Ramp	Ramp
Number of Lanes, N	1	1	1
Free-Flow Speed, FFS (mph)	55	55	45
Volume, V (veh/h)	481	512	31
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	8%	7%	2%
%RVs, P_R	0%	0%	0%

Performance Measures

	Upstream of Off-Ramp	Downstream of Off-Ramp	Off-Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.96	0.97	0.99
Demand Flow Rate, v_p (pc/h/ln)	556	589	35
Capacity Flow Rate, c (pc/h/ln)	2,200	2,200	2,100
v/c ratio	0.25	0.27	0.02
Density, D_{MD} (pc/mi/ln)	9.7	10.3	0.6
LOS	A	B	A

Formulas and Reference Material

$$f_{HV} = \frac{1}{1+P_T(E_T-1)+P_R(E_R-1)}$$ HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P}$$ HCM 2010, Equation 11-2

$$D_{MD} = \frac{0.0175*v_f}{N}$$ HCM 2010, Equation 13-26

Ramp Roadways Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

Diverge LOS Thresholds

LOS	Density (pc/mi/ln)
A	≤10
B	>10-20
C	>20-28
D	>28-35
E	>35
F	v/c > 1

Source: HCM 2010, Exhibit 13-2

RAMP ADD OR DROP LANE ANALYSIS (MAINLINE <55 MPH)

ATKINS

General Information

Date Performed:	3/20/2014	Freeway/Direction	WB US-52 & PAR Off Ramp
Analysis Year	2018 No Action	Junction	US-52 & PAR WB Ramp Merge
Analysis Time Period:	PM Peak	Segment ID	2105
Project Description:	Navy Base ICTF		

Inputs

	Mainline Upstream Ramp	Mainline Downstream Ramp	Ramp
Number of Lanes, N	1	1	1
Free-Flow Speed, FFS (mph)	55	55	45
Volume, V (veh/h)	172	247	75
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	19%	13%	2%
%RVs, P_R	0%	0%	0%

Performance Measures

	Upstream of Off-Ramp	Downstream of Off-Ramp	Off-Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.91	0.94	0.99
Demand Flow Rate, v_p (pc/h/ln)	209	292	84
Capacity Flow Rate, c (pc/h/ln)	2,200	2,200	2,100
v/c ratio	0.10	0.13	0.04
Density, D_{MD} (pc/mi/ln)	3.7	5.1	1.5
LOS	A	A	A

Formulas and Reference Material

$$f_{HV} = \frac{1}{1+P_T(E_T-1)+P_R(E_R-1)}$$ HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P}$$ HCM 2010, Equation 11-2

$$D_{MD} = \frac{0.0175*v_f}{N}$$ HCM 2010, Equation 13-26

Ramp Roadways Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

Diverge LOS Thresholds

LOS	Density (pc/mi/ln)
A	≤10
B	>10-20
C	>20-28
D	>28-35
E	>35
F	v/c > 1

Source: HCM 2010, Exhibit 13-2

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-26 WB
Agency or Company	Atkins	Junction	2110 - WB On from US-52 & PAR
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2018 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Number of Lanes, N: 3	☐ Yes ☐ On
☑ No ☐ Off	Acceleration Lane Length, L_A: 180	☑ No ☐ Off
L_{up} = ft	Deceleration Lane Length L_D:	L_{down} = ft
V_u = veh/h	Freeway Volume, V_F: 3179	V_D = veh/h
	Ramp Volume, V_R: 512	
	Freeway Free-Flow Speed, S_{FF}: 60.0	
	Ramp Free-Flow Speed, S_{FR}: 45.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	3179	0.90	Level	4	0	0.980	1.00	3603
Ramp	512	0.90	Level	7	0	0.966	1.00	589
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 0.583 using Equation (Exhibit 13-6)

V_{12} = 2099 pc/h

V_3 or V_{av34} 1504 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	4192	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	2688	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = 25.0 (pc/mi/ln)

LOS = C (Exhibit 13-2)

Speed Determination

M_S = 0.362 (Exibit 13-11)

S_R= 53.5 mph (Exhibit 13-11)

S_0= 56.4 mph (Exhibit 13-11)

S = 54.5 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-26 WB
Agency or Company	Atkins	Junction	2110 - WB On from US-52 & PAR
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2018 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Number of Lanes, N: 3	☐ Yes ☐ On
☑ No ☐ Off	Acceleration Lane Length, L_A: 180	☑ No ☐ Off
L_{up} = ft	Deceleration Lane Length L_D:	L_{down} = ft
V_u = veh/h	Freeway Volume, V_F: 4866	V_D = veh/h
	Ramp Volume, V_R: 247	
	Freeway Free-Flow Speed, S_{FF}: 60.0	
	Ramp Free-Flow Speed, S_{FR}: 45.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	4866	0.90	Level	3	0	0.985	1.00	5488
Ramp	247	0.90	Level	13	0	0.939	1.00	292
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 0.583 using Equation (Exhibit 13-6)

V_{12} = 3197 pc/h

V_3 or V_{av34} 2291 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	5780	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	3489	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = 31.4 (pc/mi/ln)

LOS = D (Exhibit 13-2)

Speed Determination

M_S = 0.433 (Exibit 13-11)

S_R= 52.2 mph (Exhibit 13-11)

S_0= 53.6 mph (Exhibit 13-11)

S = 52.7 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-26 WB*
Agency or Company	*Atkins*	From/To	*2120 - US-52 to Cosgrove*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2018 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*3691*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*3*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.985*

Speed Inputs			Calc Speed Adj and FFS		
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f_{LW}		mph
Number of Lanes, N	*3*		f_{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	*60.0*	mph	FFS	*60.0*	mph
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures			Design (N)	
Operational (LOS)			Design (N)	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1388*	pc/h/ln	Design LOS	
S	*60.0*	mph	v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h/ln
D = v_p / S	*23.1*	pc/mi/ln	S	mph
LOS	*C*		D = v_p / S	pc/mi/ln
			Required Number of Lanes, N	

Glossary		Factor Location	
N - Number of lanes	S - Speed	E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
V - Hourly volume	D - Density	E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 11-18	TRD - Page 11-11
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 11-2, 11-3	
DDHV - Directional design hour volume			

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F-2751

BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-26 WB*
Agency or Company	*Atkins*	From/To	*2120 - US-52 to Cosgrove*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*PM Peak*	Analysis Year	*2018 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*5113*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*3*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.985*

Speed Inputs			Calc Speed Adj and FFS		
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f_{LW}		mph
Number of Lanes, N	*3*		f_{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	*60.0*	mph	FFS	*60.0*	mph
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures			Design (N)	
Operational (LOS)			Design (N)	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1922*	pc/h/ln	Design LOS	
			v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h/ln
S	*58.1*	mph	S	mph
D = v_p / S	*33.1*	pc/mi/ln	D = v_p / S	pc/mi/ln
LOS	*D*		Required Number of Lanes, N	

Glossary		Factor Location	
N - Number of lanes	S - Speed	E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
V - Hourly volume	D - Density	E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 11-18	TRD - Page 11-11
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 11-2, 11-3	
DDHV - Directional design hour volume			

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F-2752

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-26 WB
Agency or Company	Atkins	Junction	2130-WB Off to Cosgrove NB
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2018 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Number of Lanes, N: 3	☐ Yes ☐ On
☑ No ☐ Off	Acceleration Lane Length, L_A:	☑ No ☐ Off
L_{up} = ft	Deceleration Lane Length L_D: 525	L_{down} = ft
V_u = veh/h	Freeway Volume, V_F: 3691	V_D = veh/h
	Ramp Volume, V_R: 414	
	Freeway Free-Flow Speed, S_{FF}: 60.0	
	Ramp Free-Flow Speed, S_{FR}: 45.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	3691	0.90	Level	3	0	0.985	1.00	4163
Ramp	414	0.90	Level	9	0	0.957	1.00	481
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 0.634 using Equation (Exhibit 13-7)

V_{12} = 2815 pc/h

V_3 or V_{av34} 1348 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	4163	Exhibit 13-8	6900	No
$V_{FO} = V_F - V_R$	3682	Exhibit 13-8	6900	No
V_R	481	Exhibit 13-10	2100	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	2815	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = 23.7 (pc/mi/ln)

LOS = C (Exhibit 13-2)

Speed Determination

D_s = 0.341 (Exhibit 13-12)

S_R= 53.9 mph (Exhibit 13-12)

S_0= 64.5 mph (Exhibit 13-12)

S = 56.9 mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-26 WB
Agency or Company	Atkins	Junction	2130-WB Off to Cosgrove NB
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2018 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Number of Lanes, N	3	Downstream Adj Ramp	
☐ Yes	☐ On	Acceleration Lane Length, L_A		☐ Yes	☐ On
☑ No	☐ Off	Deceleration Lane Length L_D	525	☑ No	☐ Off
L_{up} =	ft	Freeway Volume, V_F	5113	L_{down} =	ft
V_u =	veh/h	Ramp Volume, V_R	378	V_D =	veh/h
		Freeway Free-Flow Speed, S_{FF}	60.0		
		Ramp Free-Flow Speed, S_{FR}	45.0		

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	5113	0.90	Level	3	0	0.985	1.00	5766
Ramp	378	0.90	Level	9	0	0.957	1.00	439
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 0.596 using Equation (Exhibit 13-7)

V_{12} = 3612 pc/h

V_3 or V_{av34} 2154 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	5766	Exhibit 13-8	6900	No
$V_{FO} = V_F - V_R$	5327	Exhibit 13-8	6900	No
V_R	439	Exhibit 13-10	2100	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	3612	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = 30.6 (pc/mi/ln)

LOS = D (Exhibit 13-2)

Speed Determination

D_s = 0.338 (Exhibit 13-12)

S_R= 53.9 mph (Exhibit 13-12)

S_0= 61.3 mph (Exhibit 13-12)

S = 56.5 mph (Exhibit 13-13)

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-26 WB*
Agency or Company	*Atkins*	From/To	*2135-Cosg NB Off to Cosg NB On*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2018 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*3277*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*4*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.980*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*3*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*60.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*60.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1238*	pc/h/ln
S	*60.0*	mph
D = v_p / S	*20.6*	pc/mi/ln
LOS	*C*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-26 WB*
Agency or Company	*Atkins*	From/To	*2135-Cosg NB Off to Cosg NB On*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*PM Peak*	Analysis Year	*2018 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*4735*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*3*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.985*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*3*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*60.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*60.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1780*	pc/h/ln
S	*59.4*	mph
D = v_p / S	*30.0*	pc/mi/ln
LOS	*D*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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Navy Base ICTF

FREEWAY WEAVING WORKSHEET

General Information

Analyst	AJR
Agency/Company	Atkins
Date Performed	7/25/2014
Analysis Time Period	AM Peak

Site Information

Freeway/Dir of Travel	I-26 WB
Weaving Segment Location	2140 - Cosgrove NB to Cos. SB
Analysis Year	2018 No Action

Project Description *Navy Base ICTF*

Inputs

Weaving configuration	One-Sided	Segment type	Freeway
Weaving number of lanes, N	4	Freeway minimum speed, S_{MIN}	15
Weaving segment length, L_S	560ft	Freeway maximum capacity, C_{IFL}	2300
Freeway free-flow speed, FFS	60 mph	Terrain type	Level

Conversions to pc/h Under Base Conditions

	V (veh/h)	PHF	Truck (%)	RV (%)	E_T	E_R	f_{HV}	f_p	v (pc/h)
V_{FF}	2919	0.90	4	0	1.5	1.2	0.980	1.00	3308
V_{RF}	864	0.90	19	0	1.5	1.2	0.913	1.00	1051
V_{FR}	358	0.90	22	0	1.5	1.2	0.901	1.00	442
V_{RR}	0	0.90	0	0	1.5	1.2	1.000	1.00	0
V_{NW}	3308							V =	4801
V_W	1493								
VR	0.311								

Configuration Characteristics

Minimum maneuver lanes, N_{WL}	2 lc	Minimum weaving lane changes, LC_{MIN}	1493 lc/h
Interchange density, ID	1.0 int/mi	Weaving lane changes, LC_W	1668 lc/h
Minimum RF lane changes, LC_{RF}	1 lc/pc	Non-weaving lane changes, LC_{NW}	215 lc/h
Minimum FR lane changes, LC_{FR}	1 lc/pc	Total lane changes, LC_{ALL}	1883 lc/h
Minimum RR lane changes, LC_{RR}	lc/pc	Non-weaving vehicle index, I_{NW}	185

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment flow rate, v	4801 pc/h	Weaving intensity factor, W	0.588
Weaving segment capacity, c_w	7478 veh/h	Weaving segment speed, S	43.4 mph
Weaving segment v/c ratio	0.629	Average weaving speed, S_W	43.3 mph
Weaving segment density, D	27.6 pc/mi/ln	Average non-weaving speed, S_{NW}	43.5 mph
Level of Service, LOS	C	Maximum weaving length, L_{MAX}	5702 ft

Notes

a. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments".
b. For volumes that exceed the weaving segment capacity, the level of service is "F".

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Navy Base ICTF

FREEWAY WEAVING WORKSHEET

General Information

Analyst	AJR
Agency/Company	Atkins
Date Performed	7/25/2014
Analysis Time Period	PM Peak

Site Information

Freeway/Dir of Travel	I-26 WB
Weaving Segment Location	2140 - Cosgrove NB to Cos. SB
Analysis Year	2018 No Action

Project Description *Navy Base ICTF*

Inputs

Weaving configuration	One-Sided
Weaving number of lanes, N	4
Weaving segment length, L_S	560ft
Freeway free-flow speed, FFS	60 mph
Segment type	Freeway
Freeway minimum speed, S_{MIN}	15
Freeway maximum capacity, C_{IFL}	2300
Terrain type	Level

Conversions to pc/h Under Base Conditions

	V (veh/h)	PHF	Truck (%)	RV (%)	E_T	E_R	f_{HV}	f_p	v (pc/h)
V_{FF}	3902	0.90	3	0	1.5	1.2	0.985	1.00	4401
V_{RF}	780	0.90	18	0	1.5	1.2	0.917	1.00	945
V_{FR}	833	0.90	8	0	1.5	1.2	0.962	1.00	963
V_{RR}	0	0.90	0	0	1.5	1.2	1.000	1.00	0
V_{NW}	4401							V =	6309
V_W	1908								
VR	0.302								

Configuration Characteristics

Minimum maneuver lanes, N_{WL}	2 lc	Minimum weaving lane changes, LC_{MIN}	1908 lc/h
Interchange density, ID	1.0 int/mi	Weaving lane changes, LC_W	2083 lc/h
Minimum RF lane changes, LC_{RF}	1 lc/pc	Non-weaving lane changes, LC_{NW}	440 lc/h
Minimum FR lane changes, LC_{FR}	1 lc/pc	Total lane changes, LC_{ALL}	2523 lc/h
Minimum RR lane changes, LC_{RR}	lc/pc	Non-weaving vehicle index, I_{NW}	246

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment flow rate, v	6309 pc/h	Weaving intensity factor, W	0.741
Weaving segment capacity, c_w	7543 veh/h	Weaving segment speed, S	39.3 mph
Weaving segment v/c ratio	0.824	Average weaving speed, S_W	40.8 mph
Weaving segment density, D	40.1 pc/mi/ln	Average non-weaving speed, S_{NW}	38.7 mph
Level of Service, LOS	E	Maximum weaving length, L_{MAX}	5610 ft

Notes

a. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments".
b. For volumes that exceed the weaving segment capacity, the level of service is "F".

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-26 WB*
Agency or Company	*Atkins*	From/To	*2145-Cosg SB Off to Cosg SB On*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2018 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*3783*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*4*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.980*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*3*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*60.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*60.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1429*	pc/h/ln
S	*60.0*	mph
D = v_p / S	*23.8*	pc/mi/ln
LOS	*C*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-26 WB*
Agency or Company	*Atkins*	From/To	*2145-Cosg SB Off to Cosg SB On*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*PM Peak*	Analysis Year	*2018 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*4682*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*3*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.985*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*3*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*60.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*60.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1760*	pc/h/ln
S	*59.5*	mph
D = v_p / S	*29.6*	pc/mi/ln
LOS	*D*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-26 WB
Agency or Company	Atkins	Junction	2150 - WB On from Cosgrove SB
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2018 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Number of Lanes, N: 3	☑ Yes ☐ On
☑ No ☐ Off	Acceleration Lane Length, L_A: 425	☐ No ☑ Off
L_{up} = ft	Deceleration Lane Length L_D:	L_{down} = 2390 ft
V_u = veh/h	Freeway Volume, V_F: 3783	V_D = 355 veh/h
	Ramp Volume, V_R: 151	
	Freeway Free-Flow Speed, S_{FF}: 60.0	
	Ramp Free-Flow Speed, S_{FR}: 45.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	3783	0.90	Level	4	0	0.980	1.00	4287
Ramp	151	0.90	Level	21	0	0.905	1.00	185
UpStream								
DownStream	355	0.90	Level	19	0	0.913	1.00	432

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = 2785.75 (Equation 13-6 or 13-7)

P_{FM} = 0.596 using Equation (Exhibit 13-6)

V_{12} = 2556 pc/h

V_3 or V_{av34} 1731 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * $V_{12}/2$ ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	4472	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	2741	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = 24.1 (pc/mi/ln)

LOS = C (Exhibit 13-2)

Speed Determination

M_S = 0.343 (Exibit 13-11)

S_R= 53.8 mph (Exhibit 13-11)

S_0= 55.6 mph (Exhibit 13-11)

S = 54.5 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * $V_{12}/2$ ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-26 WB
Agency or Company	Atkins	Junction	2150 - WB On from Cosgrove SB
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2018 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Number of Lanes, N: 3	☑ Yes ☐ On
☑ No ☐ Off	Acceleration Lane Length, L_A: 425	☐ No ☑ Off
L_{up} = ft	Deceleration Lane Length L_D:	L_{down} = 2390 ft
V_u = veh/h	Freeway Volume, V_F: 4682	V_D = 429 veh/h
	Ramp Volume, V_R: 328	
	Freeway Free-Flow Speed, S_{FF}: 60.0	
	Ramp Free-Flow Speed, S_{FR}: 45.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	4682	0.90	Level	3	0	0.985	1.00	5280
Ramp	328	0.90	Level	9	0	0.957	1.00	381
UpStream								
DownStream	429	0.90	Level	14	0	0.935	1.00	510

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = 3288.73 (Equation 13-6 or 13-7)

P_{FM} = 0.605 using Equation (Exhibit 13-6)

V_{12} = 3193 pc/h

V_3 or V_{av34} 2087 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * $V_{12}/2$ ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	5661	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	3574	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = 30.5 (pc/mi/ln)

LOS = D (Exhibit 13-2)

Speed Determination

M_S = 0.422 (Exibit 13-11)

S_R= 52.4 mph (Exhibit 13-11)

S_0= 54.3 mph (Exhibit 13-11)

S = 53.1 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * $V_{12}/2$ ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-26 WB
Agency or Company	Atkins	Junction	2160-WB Off to Dorchester
Date Performed	3/20/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2018 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Number of Lanes, N	3	Downstream Adj Ramp	
☑ Yes	☑ On	Acceleration Lane Length, L_A		☐ Yes	☐ On
☐ No	☐ Off	Deceleration Lane Length L_D	425	☑ No	☐ Off
L_{up} =	2390 ft	Freeway Volume, V_F	3934	L_{down} =	ft
V_u =	151 veh/h	Ramp Volume, V_R	355	V_D =	veh/h
		Freeway Free-Flow Speed, S_{FF}	60.0		
		Ramp Free-Flow Speed, S_{FR}	45.0		

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	3934	0.90	Level	4	0	0.980	1.00	4459
Ramp	355	0.90	Level	19	0	0.913	1.00	432
UpStream	151	0.90	Level	21	0	0.905	1.00	185
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = 1314.62 (Equation 13-12 or 13-13)

P_{FD} = 0.629 using Equation (Exhibit 13-7)

V_{12} = 2964 pc/h

V_3 or V_{av34} 1495 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	4459	Exhibit 13-8	6900	No
$V_{FO} = V_F - V_R$	4027	Exhibit 13-8	6900	No
V_R	432	Exhibit 13-10	2100	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	2964	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = 25.9 (pc/mi/ln)

LOS = C (Exhibit 13-2)

Speed Determination

D_s = 0.337 (Exhibit 13-12)

S_R= 53.9 mph (Exhibit 13-12)

S_0= 63.9 mph (Exhibit 13-12)

S = 56.9 mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-26 WB
Agency or Company	Atkins	Junction	2160-WB Off to Dorchester
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2018 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Number of Lanes, N	3	Downstream Adj Ramp	
☑ Yes	☑ On	Acceleration Lane Length, L_A		☐ Yes	☐ On
☐ No	☐ Off	Deceleration Lane Length L_D	425	☑ No	☐ Off
L_{up} =	2390 ft	Freeway Volume, V_F	5010	L_{down} =	ft
V_u =	328 veh/h	Ramp Volume, V_R	429	V_D =	veh/h
		Freeway Free-Flow Speed, S_{FF}	60.0		
		Ramp Free-Flow Speed, S_{FR}	45.0		

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	5010	0.90	Level	3	0	0.985	1.00	5650
Ramp	429	0.90	Level	14	0	0.935	1.00	510
UpStream	328	0.90	Level	9	0	0.957	1.00	381
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = 2349.10 (Equation 13-12 or 13-13)

P_{FD} = 0.595 using Equation (Exhibit 13-7)

V_{12} = 3570 pc/h

V_3 or V_{av34} 2080 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	5650	Exhibit 13-8	6900	No
$V_{FO} = V_F - V_R$	5140	Exhibit 13-8	6900	No
V_R	510	Exhibit 13-10	2100	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	3570	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = 31.1 (pc/mi/ln)

LOS = D (Exhibit 13-2)

Speed Determination

D_s = 0.344 (Exhibit 13-12)

S_R= 53.8 mph (Exhibit 13-12)

S_0= 61.6 mph (Exhibit 13-12)

S = 56.4 mph (Exhibit 13-13)

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-26 WB*
Agency or Company	*Atkins*	From/To	*2165-Dorches Off to Dorches On*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2018 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*3579*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*4*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.980*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*3*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*60.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*60.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1352*	pc/h/ln
S	*60.0*	mph
D = v_p / S	*22.5*	pc/mi/ln
LOS	*C*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-26 WB*
Agency or Company	*Atkins*	From/To	*2165-Dorches Off to Dorches On*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*PM Peak*	Analysis Year	*2018 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*4581*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*3*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.985*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*3*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*60.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*60.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1722*	pc/h/ln
S	*59.7*	mph
D = v_p / S	*28.8*	pc/mi/ln
LOS	*D*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-26 WB
Agency or Company	Atkins	Junction	2170 - WB On from Dorchester
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2018 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Number of Lanes, N: 3	☐ Yes ☐ On
☑ No ☐ Off	Acceleration Lane Length, L_A: 600	☑ No ☐ Off
L_{up} = ft	Deceleration Lane Length L_D:	L_{down} = ft
V_u = veh/h	Freeway Volume, V_F: 3579	V_D = veh/h
	Ramp Volume, V_R: 232	
	Freeway Free-Flow Speed, S_{FF}: 60.0	
	Ramp Free-Flow Speed, S_{FR}: 45.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	3579	0.90	Level	4	0	0.980	1.00	4056
Ramp	232	0.90	Level	25	0	0.889	1.00	290
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 0.594 using Equation (Exhibit 13-6)

V_{12} = 2410 pc/h

V_3 or V_{av34} 1646 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	4346	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	2700	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = 22.6 (pc/mi/ln)

LOS = C (Exhibit 13-2)

Speed Determination

M_S = 0.325 (Exibit 13-11)

S_R= 54.1 mph (Exhibit 13-11)

S_0= 55.9 mph (Exhibit 13-11)

S = 54.8 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-26 WB
Agency or Company	Atkins	Junction	2170 - WB On from Dorchester
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2018 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Number of Lanes, N: 3	☐ Yes ☐ On
☑ No ☐ Off	Acceleration Lane Length, L_A: 600	☑ No ☐ Off
L_{up} = ft	Deceleration Lane Length L_D:	L_{down} = ft
V_u = veh/h	Freeway Volume, V_F: 4581	V_D = veh/h
	Ramp Volume, V_R: 520	
	Freeway Free-Flow Speed, S_{FF}: 60.0	
	Ramp Free-Flow Speed, S_{FR}: 45.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	4581	0.90	Level	3	0	0.985	1.00	5166
Ramp	520	0.90	Level	9	0	0.957	1.00	604
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 0.594 using Equation (Exhibit 13-6)

V_{12} = 3070 pc/h

V_3 or V_{av34} 2096 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	5770	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	3674	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = 30.1 (pc/mi/ln)

LOS = D (Exhibit 13-2)

Speed Determination

M_S = 0.421 (Exibit 13-11)

S_R= 52.4 mph (Exhibit 13-11)

S_0= 54.3 mph (Exhibit 13-11)

S = 53.1 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-26 WB*
Agency or Company	*Atkins*	From/To	*2180 - Dorchester to Montague*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2018 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*3811*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*3*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.985*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*3*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*60.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*60.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1433*	pc/h/ln
S	*60.0*	mph
D = v_p / S	*23.9*	pc/mi/ln
LOS	*C*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-26 WB*
Agency or Company	*Atkins*	From/To	*2180 - Dorchester to Montague*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*PM Peak*	Analysis Year	*2018 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*5101*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*3*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.985*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*3*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*60.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*60.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1918*	pc/h/ln
S	*58.2*	mph
D = v_p / S	*33.0*	pc/mi/ln
LOS	*D*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-26 WB
Agency or Company	Atkins	Junction	2190-WB Off to Montague
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2018 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Number of Lanes, N	3	Downstream Adj Ramp	
☐ Yes	☐ On	Acceleration Lane Length, L_A		☐ Yes	☐ On
☑ No	☐ Off	Deceleration Lane Length L_D	240	☑ No	☐ Off
L_{up} =	ft	Freeway Volume, V_F	3811	L_{down} =	ft
V_u =	veh/h	Ramp Volume, V_R	978	V_D =	veh/h
		Freeway Free-Flow Speed, S_{FF}	60.0		
		Ramp Free-Flow Speed, S_{FR}	45.0		

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	3811	0.90	Level	3	0	0.985	1.00	4298
Ramp	978	0.90	Level	10	0	0.952	1.00	1141
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 0.600 using Equation (Exhibit 13-7)

V_{12} = 3035 pc/h

V_3 or V_{av34} 1263 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	4298	Exhibit 13-8	6900	No
$V_{FO} = V_F - V_R$	3157	Exhibit 13-8	6900	No
V_R	1141	Exhibit 13-10	2100	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	3035	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = 28.2 (pc/mi/ln)

LOS = D (Exhibit 13-2)

Speed Determination

D_s = 0.401 (Exhibit 13-12)

S_R= 52.8 mph (Exhibit 13-12)

S_0= 64.8 mph (Exhibit 13-12)

S = 55.8 mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-26 WB
Agency or Company	Atkins	Junction	2190-WB Off to Montague
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2018 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Number of Lanes, N: 3	☐ Yes ☐ On
☑ No ☐ Off	Acceleration Lane Length, L_A:	☑ No ☐ Off
L_{up} = ft	Deceleration Lane Length L_D: 240	L_{down} = ft
V_u = veh/h	Freeway Volume, V_F: 5101	V_D = veh/h
	Ramp Volume, V_R: 990	
	Freeway Free-Flow Speed, S_{FF}: 60.0	
	Ramp Free-Flow Speed, S_{FR}: 45.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	5101	0.90	Level	3	0	0.985	1.00	5753
Ramp	990	0.90	Level	8	0	0.962	1.00	1144
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 0.564 using Equation (Exhibit 13-7)

V_{12} = 3741 pc/h

V_3 or V_{av34} 2012 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	5753	Exhibit 13-8	6900	No
$V_{FO} = V_F - V_R$	4609	Exhibit 13-8	6900	No
V_R	1144	Exhibit 13-10	2100	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	3741	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = 34.3 (pc/mi/ln)

LOS = D (Exhibit 13-2)

Speed Determination

D_s = 0.401 (Exhibit 13-12)

S_R= 52.8 mph (Exhibit 13-12)

S_0= 61.9 mph (Exhibit 13-12)

S = 55.6 mph (Exhibit 13-13)

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-26 WB*
Agency or Company	*Atkins*	From/To	*2195-Montagu Off to Montagu On*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2018 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*2833*	veh/h	Peak-Hour Factor, PHF	*0.90*	
AADT		veh/day	%Trucks and Buses, P_T	*4*	
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*	
Peak-Hr Direction Prop, D			General Terrain:	*Level*	
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*	

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.980*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*3*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*60.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*60.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1070*	pc/h/ln
S	*60.0*	mph
D = v_p / S	*17.8*	pc/mi/ln
LOS	*B*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-26 WB*
Agency or Company	*Atkins*	From/To	*2195-Montagu Off to Montagu On*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*PM Peak*	Analysis Year	*2018 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*4111*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*3*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.985*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*3*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*60.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*60.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1545*	pc/h/ln
S	*60.0*	mph
D = v_p / S	*25.8*	pc/mi/ln
LOS	*C*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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Navy Base ICTF

FREEWAY WEAVING WORKSHEET

General Information

Analyst	AJR
Agency/Company	Atkins
Date Performed	7/25/2014
Analysis Time Period	AM Peak

Site Information

Freeway/Dir of Travel	I-26 WB
Weaving Segment Location	2200 - Montague to I-526 EB
Analysis Year	2018 No Action

Project Description *Navy Base ICTF*

Inputs

Weaving configuration	One-Sided	Segment type	Freeway
Weaving number of lanes, N	4	Freeway minimum speed, S_{MIN}	15
Weaving segment length, L_S	1920ft	Freeway maximum capacity, C_{IFL}	2300
Freeway free-flow speed, FFS	60 mph	Terrain type	Level

Conversions to pc/h Under Base Conditions

	V (veh/h)	PHF	Truck (%)	RV (%)	E_T	E_R	f_{HV}	f_p	v (pc/h)
V_{FF}	2390	0.90	4	0	1.5	1.2	0.980	1.00	2709
V_{RF}	354	0.90	22	0	1.5	1.2	0.901	1.00	437
V_{FR}	443	0.90	8	0	1.5	1.2	0.962	1.00	512
V_{RR}	65	0.90	22	0	1.5	1.2	0.901	1.00	80
V_{NW}	2789							V =	3738
V_W	949								
VR	0.254								

Configuration Characteristics

Minimum maneuver lanes, N_{WL}	2 lc	Minimum weaving lane changes, LC_{MIN}	949 lc/h
Interchange density, ID	0.8 int/mi	Weaving lane changes, LC_W	1351 lc/h
Minimum RF lane changes, LC_{RF}	1 lc/pc	Non-weaving lane changes, LC_{NW}	845 lc/h
Minimum FR lane changes, LC_{FR}	1 lc/pc	Total lane changes, LC_{ALL}	2196 lc/h
Minimum RR lane changes, LC_{RR}	lc/pc	Non-weaving vehicle index, I_{NW}	428

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment flow rate, v	3738 pc/h	Weaving intensity factor, W	0.251
Weaving segment capacity, c_w	8067 veh/h	Weaving segment speed, S	49.2 mph
Weaving segment v/c ratio	0.454	Average weaving speed, S_W	51.0 mph
Weaving segment density, D	19.0 pc/mi/ln	Average non-weaving speed, S_{NW}	48.7 mph
Level of Service, LOS	B	Maximum weaving length, L_{MAX}	5094 ft

Notes

a. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments".
b. For volumes that exceed the weaving segment capacity, the level of service is "F".

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Navy Base ICTF

FREEWAY WEAVING WORKSHEET

General Information

Analyst	AJR
Agency/Company	Atkins
Date Performed	7/25/2014
Analysis Time Period	PM Peak

Site Information

Freeway/Dir of Travel	I-26 WB
Weaving Segment Location	2200 - Montague to I-526 EB
Analysis Year	2018 No Action

Project Description *Navy Base ICTF*

Inputs

Weaving configuration	One-Sided	Segment type	Freeway
Weaving number of lanes, N	4	Freeway minimum speed, S_{MIN}	15
Weaving segment length, L_S	1920ft	Freeway maximum capacity, C_{IFL}	2300
Freeway free-flow speed, FFS	60 mph	Terrain type	Level

Conversions to pc/h Under Base Conditions

	V (veh/h)	PHF	Truck (%)	RV (%)	E_T	E_R	f_{HV}	f_p	v (pc/h)
V_{FF}	3755	0.90	3	0	1.5	1.2	0.985	1.00	4235
V_{RF}	1059	0.90	7	0	1.5	1.2	0.966	1.00	1218
V_{FR}	356	0.90	8	0	1.5	1.2	0.962	1.00	411
V_{RR}	101	0.90	8	0	1.5	1.2	0.962	1.00	117
V_{NW}	4352							V =	5981
V_W	1629								
VR	0.272								

Configuration Characteristics

Minimum maneuver lanes, N_{WL}	2 lc	Minimum weaving lane changes, LC_{MIN}	1629 lc/h
Interchange density, ID	0.8 int/mi	Weaving lane changes, LC_W	2031 lc/h
Minimum RF lane changes, LC_{RF}	1 lc/pc	Non-weaving lane changes, LC_{NW}	1167 lc/h
Minimum FR lane changes, LC_{FR}	1 lc/pc	Total lane changes, LC_{ALL}	3198 lc/h
Minimum RR lane changes, LC_{RR}	lc/pc	Non-weaving vehicle index, I_{NW}	668

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment flow rate, v	5981 pc/h	Weaving intensity factor, W	0.338
Weaving segment capacity, c_w	8047 veh/h	Weaving segment speed, S	42.9 mph
Weaving segment v/c ratio	0.732	Average weaving speed, S_W	48.6 mph
Weaving segment density, D	34.9 pc/mi/ln	Average non-weaving speed, S_{NW}	41.1 mph
Level of Service, LOS	D	Maximum weaving length, L_{MAX}	5289 ft

Notes

a. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments".
b. For volumes that exceed the weaving segment capacity, the level of service is "F".

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-26 WB
Agency or Company	Atkins	Junction	2210-WB Off to I-526 WB
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2018 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Number of Lanes, N	3	Downstream Adj Ramp	
☐ Yes	☐ On	Acceleration Lane Length, L_A		☐ Yes	☐ On
☑ No	☐ Off	Deceleration Lane Length L_D	830	☑ No	☐ Off
L_{up} =	ft	Freeway Volume, V_F	2744	L_{down} =	ft
V_u =	veh/h	Ramp Volume, V_R	275	V_D =	veh/h
		Freeway Free-Flow Speed, S_{FF}	60.0		
		Ramp Free-Flow Speed, S_{FR}	25.0		

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	2744	0.90	Level	13	0	0.939	1.00	3247
Ramp	275	0.90	Level	7	0	0.966	1.00	316
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 0.664 using Equation (Exhibit 13-7)

V_{12} = 2263 pc/h

V_3 or V_{av34} 984 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	3247	Exhibit 13-8	6900	No
$V_{FO} = V_F - V_R$	2931	Exhibit 13-8	6900	No
V_R	316	Exhibit 13-10	1900	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	2263	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = 16.2 (pc/mi/ln)

LOS = B (Exhibit 13-2)

Speed Determination

D_s = 0.586 (Exhibit 13-12)

S_R= 49.4 mph (Exhibit 13-12)

S_0= 65.8 mph (Exhibit 13-12)

S = 53.5 mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-26 WB
Agency or Company	Atkins	Junction	2210-WB Off to I-526 WB
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2018 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Number of Lanes, N	3	Downstream Adj Ramp	
☐ Yes	☐ On	Acceleration Lane Length, L_A		☐ Yes	☐ On
☑ No	☐ Off	Deceleration Lane Length L_D	830	☑ No	☐ Off
L_{up} =	ft	Freeway Volume, V_F	4814	L_{down} =	ft
V_u =	veh/h	Ramp Volume, V_R	338	V_D =	veh/h
		Freeway Free-Flow Speed, S_{FF}	60.0		
		Ramp Free-Flow Speed, S_{FR}	25.0		

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	4814	0.90	Level	10	0	0.952	1.00	5616
Ramp	338	0.90	Level	5	0	0.976	1.00	385
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 0.602 using Equation (Exhibit 13-7)

V_{12} = 3533 pc/h

V_3 or V_{av34} 2083 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	5616	Exhibit 13-8	6900	No
$V_{FO} = V_F - V_R$	5231	Exhibit 13-8	6900	No
V_R	385	Exhibit 13-10	1900	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	3533	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = 27.2 (pc/mi/ln)

LOS = C (Exhibit 13-2)

Speed Determination

D_s = 0.593 (Exhibit 13-12)

S_R= 49.3 mph (Exhibit 13-12)

S_0= 61.6 mph (Exhibit 13-12)

S = 53.3 mph (Exhibit 13-13)

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-26 WB*
Agency or Company	*Atkins*	From/To	*2215- I-526 WB Off to EB&WB On*
Date Performed	*4/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2018 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*2469*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*13*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.939*

Speed Inputs			Calc Speed Adj and FFS		
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f_{LW}		mph
Number of Lanes, N	*3*		f_{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	*60.0*	mph	FFS	*60.0*	mph
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures			Design (N)	
Operational (LOS)			Design (N)	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*974*	pc/h/ln	Design LOS	
			v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h/ln
S	*60.0*	mph	S	mph
D = v_p / S	*16.2*	pc/mi/ln	D = v_p / S	pc/mi/ln
LOS	*B*		Required Number of Lanes, N	

Glossary		Factor Location	
N - Number of lanes	S - Speed	E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
V - Hourly volume	D - Density	E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 11-18	TRD - Page 11-11
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 11-2, 11-3	
DDHV - Directional design hour volume			

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-26 WB*
Agency or Company	*Atkins*	From/To	*2215- I-526 WB Off to EB&WB On*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*PM Peak*	Analysis Year	*2018 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*4476*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*10*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.952*

Speed Inputs			Calc Speed Adj and FFS		
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f_{LW}		mph
Number of Lanes, N	*3*		f_{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	*60.0*	mph	FFS	*60.0*	mph
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures			Design (N)	
Operational (LOS)			Design (N)	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1741*	pc/h/ln	Design LOS	
S	*59.6*	mph	v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h/ln
D = v_p / S	*29.2*	pc/mi/ln	S	mph
LOS	*D*		D = v_p / S	pc/mi/ln
			Required Number of Lanes, N	

Glossary		Factor Location	
N - Number of lanes	S - Speed	E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
V - Hourly volume	D - Density	E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 11-18	TRD - Page 11-11
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 11-2, 11-3	
DDHV - Directional design hour volume			

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RAMP ADD OR DROP LANE ANALYSIS (MAINLINE <55 MPH)

ATKINS

General Information

Date Performed:	7/25/2014	Freeway/Direction	I-26 WB
Analysis Year	2018 No Action	Junction	On from 526 WB & EB
Analysis Time Period:	AM Peak	Segment ID	2218
Project Description:	Navy Base ICTF		

Inputs

	Mainline Upstream Ramp	Mainline Downstream Ramp	Ramp
Number of Lanes, N	1	2	1
Free-Flow Speed, FFS (mph)	55	55	55
Volume, V (veh/h)	1,824	3,157	1,333
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	13%	30%	54%
%RVs, P_R	0%	0%	0%

Performance Measures

	Upstream of Off-Ramp	Downstream of Off-Ramp	Off-Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.94	0.87	0.79
Demand Flow Rate, v_p (pc/h/ln)	2,158	2,017	1,881
Capacity Flow Rate, c (pc/h/ln)	2,200	2,200	2,200
v/c ratio	0.98	0.92	0.86
Density, D_{MD} (pc/mi/ln)	37.8	35.3	32.9
LOS	E	E	D

Formulas and Reference Material

$$f_{HV} = \frac{1}{1+P_T(E_T-1)+P_R(E_R-1)}$$ HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P}$$ HCM 2010, Equation 11-2

$$D_{MD} = \frac{0.0175*v_f}{N}$$ HCM 2010, Equation 13-26

Ramp Roadways Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

Diverge LOS Thresholds

LOS	Density (pc/mi/ln)
A	≤10
B	>10-20
C	>20-28
D	>28-35
E	>35
F	v/c > 1

Source: HCM 2010, Exhibit 13-2

RAMP ADD OR DROP LANE ANALYSIS (MAINLINE <55 MPH)

ATKINS

General Information

Date Performed:	7/25/2014	Freeway/Direction	I-26 WB
Analysis Year	2018 No Action	Junction	On from 526 WB & EB
Analysis Time Period:	PM Peak	Segment ID	2218
Project Description:	Navy Base ICTF		

Inputs

	Mainline Upstream Ramp	Mainline Downstream Ramp	Ramp
Number of Lanes, N	1	2	1
Free-Flow Speed, FFS (mph)	55	55	55
Volume, V (veh/h)	2,109	3,714	1,605
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	9%	22%	39%
%RVs, P_R	0%	0%	0%

Performance Measures

	Upstream of Off-Ramp	Downstream of Off-Ramp	Off-Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.96	0.90	0.84
Demand Flow Rate, v_p (pc/h/ln)	2,449	2,290	2,131
Capacity Flow Rate, c (pc/h/ln)	2,200	2,200	2,200
v/c ratio	1.11	1.04	0.97
Density, D_{MD} (pc/mi/ln)	42.9	40.1	37.3
LOS	F	F	E

Formulas and Reference Material

$$f_{HV} = \frac{1}{1+P_T(E_T-1)+P_R(E_R-1)}$$ HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P}$$ HCM 2010, Equation 11-2

$$D_{MD} = \frac{0.0175*v_f}{N}$$ HCM 2010, Equation 13-26

Ramp Roadways Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

Diverge LOS Thresholds

LOS	Density (pc/mi/ln)
A	≤10
B	>10-20
C	>20-28
D	>28-35
E	>35
F	v/c > 1

Source: HCM 2010, Exhibit 13-2

Navy Base ICTF

FREEWAY WEAVING WORKSHEET

General Information

Analyst	AJR
Agency/Company	Atkins
Date Performed	7/25/2014
Analysis Time Period	AM Peak

Site Information

Freeway/Dir of Travel	I-26 WB
Weaving Segment Location	2220 - 526 to Rem/Aviation C-D
Analysis Year	2018 No Action

Project Description *Navy Base ICTF*

Inputs

Weaving configuration	One-Sided	Segment type	Freeway
Weaving number of lanes, N	5	Freeway minimum speed, S_{MIN}	15
Weaving segment length, L_S	2285ft	Freeway maximum capacity, C_{IFL}	2300
Freeway free-flow speed, FFS	60 mph	Terrain type	Level

Conversions to pc/h Under Base Conditions

	V (veh/h)	PHF	Truck (%)	RV (%)	E_T	E_R	f_{HV}	f_p	v (pc/h)
V_{FF}	1914	0.90	13	0	1.5	1.2	0.939	1.00	2265
V_{RF}	2448	0.90	30	0	1.5	1.2	0.870	1.00	3128
V_{FR}	555	0.90	13	0	1.5	1.2	0.939	1.00	657
V_{RR}	709	0.90	30	0	1.5	1.2	0.870	1.00	906
V_{NW}	3171							V =	6956
V_W	3785								
VR	0.544								

Configuration Characteristics

Minimum maneuver lanes, N_{WL}	3 lc	Minimum weaving lane changes, LC_{MIN}	lc/h
Interchange density, ID	0.7 int/mi	Weaving lane changes, LC_W	lc/h
Minimum RF lane changes, LC_{RF}	0 lc/pc	Non-weaving lane changes, LC_{NW}	lc/h
Minimum FR lane changes, LC_{FR}	1 lc/pc	Total lane changes, LC_{ALL}	lc/h
Minimum RR lane changes, LC_{RR}	lc/pc	Non-weaving vehicle index, I_{NW}	362

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment flow rate, v	6956 pc/h	Weaving intensity factor, W	
Weaving segment capacity, c_w	6040 veh/h	Weaving segment speed, S	mph
Weaving segment v/c ratio	1.081	Average weaving speed, S_W	mph
Weaving segment density, D	pc/mi/ln	Average non-weaving speed, S_{NW}	mph
Level of Service, LOS	F	Maximum weaving length, L_{MAX}	6781 ft

Notes

a. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments".
b. For volumes that exceed the weaving segment capacity, the level of service is "F".

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Navy Base ICTF

FREEWAY WEAVING WORKSHEET

General Information

Analyst	AJR
Agency/Company	Atkins
Date Performed	7/25/2014
Analysis Time Period	PM Peak

Site Information

Freeway/Dir of Travel	I-26 WB
Weaving Segment Location	2220 - 526 to Rem/Aviation C-D
Analysis Year	2018 No Action

Project Description *Navy Base ICTF*

Inputs

Weaving configuration	One-Sided	Segment type	Freeway
Weaving number of lanes, N	5	Freeway minimum speed, S_{MIN}	15
Weaving segment length, L_S	2285ft	Freeway maximum capacity, C_{IFL}	2300
Freeway free-flow speed, FFS	60 mph	Terrain type	Level

Conversions to pc/h Under Base Conditions

	V (veh/h)	PHF	Truck (%)	RV (%)	E_T	E_R	f_{HV}	f_p	v (pc/h)
V_{FF}	3955	0.90	10	0	1.5	1.2	0.952	1.00	4614
V_{RF}	3281	0.90	22	0	1.5	1.2	0.901	1.00	4047
V_{FR}	521	0.90	10	0	1.5	1.2	0.952	1.00	608
V_{RR}	433	0.90	22	0	1.5	1.2	0.901	1.00	534
V_{NW}	5148							V =	9803
V_W	4655								
VR	0.475								

Configuration Characteristics

Minimum maneuver lanes, N_{WL}	3 lc	Minimum weaving lane changes, LC_{MIN}	lc/h
Interchange density, ID	0.7 int/mi	Weaving lane changes, LC_W	lc/h
Minimum RF lane changes, LC_{RF}	0 lc/pc	Non-weaving lane changes, LC_{NW}	lc/h
Minimum FR lane changes, LC_{FR}	1 lc/pc	Total lane changes, LC_{ALL}	lc/h
Minimum RR lane changes, LC_{RR}	lc/pc	Non-weaving vehicle index, I_{NW}	

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment flow rate, v	9803 pc/h	Weaving intensity factor, W	
Weaving segment capacity, c_w	7020 veh/h	Weaving segment speed, S	mph
Weaving segment v/c ratio	1.330	Average weaving speed, S_W	mph
Weaving segment density, D	pc/mi/ln	Average non-weaving speed, S_{NW}	mph
Level of Service, LOS	F	Maximum weaving length, L_{MAX}	5968 ft

Notes

a. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments".
b. For volumes that exceed the weaving segment capacity, the level of service is "F".

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-26 WB*
Agency or Company	*Atkins*	From/To	*2225- Rem/Avia CD Off to CD On*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2018 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*4362*	veh/h	Peak-Hour Factor, PHF	*0.90*	
AADT		veh/day	%Trucks and Buses, P_T	*18*	
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*	
Peak-Hr Direction Prop, D			General Terrain:	*Level*	
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*	

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.917*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*4*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*60.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*60.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1321*	pc/h/ln
S	*60.0*	mph
D = v_p / S	*22.0*	pc/mi/ln
LOS	*C*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-26 WB*
Agency or Company	*Atkins*	From/To	*2225- Rem/Avia CD Off to CD On*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*PM Peak*	Analysis Year	*2018 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*7236*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*12*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.943*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*4*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*60.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*60.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*2131*	pc/h/ln
S	*54.9*	mph
D = v_p / S	*38.8*	pc/mi/ln
LOS	*E*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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RAMP ADD OR DROP LANE ANALYSIS (MAINLINE <55 MPH)

ATKINS

General Information

Date Performed:	7/25/2014	Freeway/Direction	I-26 WB C-D
Analysis Year	2018 No Action	Junction	WB Off to Remount
Analysis Time Period:	AM Peak	Segment ID	2230
Project Description:	Navy Base ICTF		

Inputs

	Mainline Upstream Ramp	Mainline Downstream Ramp	Ramp
Number of Lanes, N	2	1	1
Free-Flow Speed, FFS (mph)	55	55	45
Volume, V (veh/h)	1,264	776	488
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	3%	3%	2%
%RVs, P_R	0%	0%	0%

Performance Measures

	Upstream of Off-Ramp	Downstream of Off-Ramp	Off-Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.99	0.99	0.99
Demand Flow Rate, v_p (pc/h/ln)	713	875	548
Capacity Flow Rate, c (pc/h/ln)	2,200	2,200	2,100
v/c ratio	0.32	0.40	0.26
Density, D_{MD} (pc/mi/ln)	12.5	15.3	9.6
LOS	B	B	A

Formulas and Reference Material

$$f_{HV} = \frac{1}{1+P_T(E_T-1)+P_R(E_R-1)}$$ HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P}$$ HCM 2010, Equation 11-2

$$D_{MD} = \frac{0.0175*v_f}{N}$$ HCM 2010, Equation 13-26

Ramp Roadways Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

Diverge LOS Thresholds

LOS	Density (pc/mi/ln)
A	≤10
B	>10-20
C	>20-28
D	>28-35
E	>35
F	v/c > 1

Source: HCM 2010, Exhibit 13-2

RAMP ADD OR DROP LANE ANALYSIS (MAINLINE <55 MPH)

ATKINS

General Information

Date Performed:	7/25/2014	Freeway/Direction	I-26 WB C-D
Analysis Year	2018 No Action	Junction	WB Off to Remount
Analysis Time Period:	PM Peak	Segment ID	2230
Project Description:	Navy Base ICTF		

Inputs

	Mainline Upstream Ramp	Mainline Downstream Ramp	Ramp
Number of Lanes, N	2	1	1
Free-Flow Speed, FFS (mph)	55	55	45
Volume, V (veh/h)	954	506	448
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	3%	4%	2%
%RVs, P_R	0%	0%	0%

Performance Measures

	Upstream of Off-Ramp	Downstream of Off-Ramp	Off-Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.99	0.98	0.99
Demand Flow Rate, v_p (pc/h/ln)	538	573	503
Capacity Flow Rate, c (pc/h/ln)	2,200	2,200	2,100
v/c ratio	0.24	0.26	0.24
Density, D_{MD} (pc/mi/ln)	9.4	10.0	8.8
LOS	A	A	A

Formulas and Reference Material

$$f_{HV} = \frac{1}{1+P_T(E_T-1)+P_R(E_R-1)}$$ HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P}$$ HCM 2010, Equation 11-2

$$D_{MD} = \frac{0.0175*v_f}{N}$$ HCM 2010, Equation 13-26

Ramp Roadways Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

Diverge LOS Thresholds

LOS	Density (pc/mi/ln)
A	≤10
B	>10-20
C	>20-28
D	>28-35
E	>35
F	v/c > 1

Source: HCM 2010, Exhibit 13-2

BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-26 WB C-D*
Agency or Company	*Atkins*	From/To	*2235-Remount Off to Remount On*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2018 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*1552*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*3*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.985*

Speed Inputs			Calc Speed Adj and FFS		
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f_{LW}		mph
Number of Lanes, N	*2*		f_{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	*55.0*	mph	FFS	*55.0*	mph
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures			Design (N)	
Operational (LOS)			Design (N)	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*875*	pc/h/ln	Design LOS	
			v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h/ln
S	*55.0*	mph	S	mph
D = v_p / S	*15.9*	pc/mi/ln	D = v_p / S	pc/mi/ln
LOS	*B*		Required Number of Lanes, N	

Glossary		Factor Location	
N - Number of lanes	S - Speed	E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
V - Hourly volume	D - Density	E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 11-18	TRD - Page 11-11
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 11-2, 11-3	
DDHV - Directional design hour volume			

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-26 WB C-D*
Agency or Company	*Atkins*	From/To	*2235-Remount Off to Remount On*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*PM Peak*	Analysis Year	*2018 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*1012*	veh/h	Peak-Hour Factor, PHF	*0.90*	
AADT		veh/day	%Trucks and Buses, P_T	*4*	
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*	
Peak-Hr Direction Prop, D			General Terrain:	*Level*	
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*	

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.980*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*55.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*55.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*573*	pc/h/ln
S	*55.0*	mph
D = v_p / S	*10.4*	pc/mi/ln
LOS	*A*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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F-2790

Navy Base ICTF

FREEWAY WEAVING WORKSHEET

General Information

Analyst	AJR
Agency/Company	Atkins
Date Performed	7/25/2014
Analysis Time Period	AM Peak

Site Information

Freeway/Dir of Travel	I-26 WB C-D
Weaving Segment Location	2240 - Remount to Aviation
Analysis Year	2018 No Action

Project Description *Navy Base ICTF*

Inputs

Weaving configuration	One-Sided	Segment type	C-D Roadway/ Multilane Highways
Weaving number of lanes, N	2		
Weaving segment length, L_S	750ft	Freeway minimum speed, S_{MIN}	15
Freeway free-flow speed, FFS	55 mph	Freeway maximum capacity, C_{IFL}	2250
		Terrain type	Level

Conversions to pc/h Under Base Conditions

	V (veh/h)	PHF	Truck (%)	RV (%)	E_T	E_R	f_{HV}	f_p	v (pc/h)
V_{FF}	0	0.90	0	0	1.5	1.2	1.000	1.00	0
V_{RF}	284	0.90	19	0	1.5	1.2	0.913	1.00	346
V_{FR}	776	0.90	3	0	1.5	1.2	0.985	1.00	875
V_{RR}	0	0.90	0	0	1.5	1.2	1.000	1.00	0
V_{NW}	0							V =	1221
V_W	1221								
VR	1.000								

Configuration Characteristics

Minimum maneuver lanes, N_{WL}	2 lc	Minimum weaving lane changes, LC_{MIN}	1221 lc/h
Interchange density, ID	0.8 int/mi	Weaving lane changes, LC_W	1274 lc/h
Minimum RF lane changes, LC_{RF}	1 lc/pc	Non-weaving lane changes, LC_{NW}	21 lc/h
Minimum FR lane changes, LC_{FR}	1 lc/pc	Total lane changes, LC_{ALL}	1295 lc/h
Minimum RR lane changes, LC_{RR}	lc/pc	Non-weaving vehicle index, I_{NW}	0

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment flow rate, v	1221 pc/h	Weaving intensity factor, W	0.348
Weaving segment capacity, c_w	2400 veh/h	Weaving segment speed, S	44.7 mph
Weaving segment v/c ratio	0.509	Average weaving speed, S_W	44.7 mph
Weaving segment density, D	13.7 pc/mi/ln	Average non-weaving speed, S_{NW}	43.3 mph
Level of Service, LOS	B	Maximum weaving length, L_{MAX}	14232 ft

Notes

a. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments".
b. For volumes that exceed the weaving segment capacity, the level of service is "F".

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Navy Base ICTF

FREEWAY WEAVING WORKSHEET

General Information

Analyst	AJR
Agency/Company	Atkins
Date Performed	7/25/2014
Analysis Time Period	PM Peak

Site Information

Freeway/Dir of Travel	I-26 WB C-D
Weaving Segment Location	2240 - Remount to Aviation
Analysis Year	2018 No Action

Project Description *Navy Base ICTF*

Inputs

Weaving configuration	One-Sided
Weaving number of lanes, N	2
Weaving segment length, L_S	750ft
Freeway free-flow speed, FFS	55 mph
Segment type	C-D Roadway/ Multilane Highways
Freeway minimum speed, S_{MIN}	15
Freeway maximum capacity, C_{IFL}	2250
Terrain type	Level

Conversions to pc/h Under Base Conditions

	V (veh/h)	PHF	Truck (%)	RV (%)	E_T	E_R	f_{HV}	f_p	v (pc/h)
V_{FF}	0	0.90	0	0	1.5	1.2	1.000	1.00	0
V_{RF}	1033	0.90	4	0	1.5	1.2	0.980	1.00	1171
V_{FR}	506	0.90	4	0	1.5	1.2	0.980	1.00	573
V_{RR}	0	0.90	0	0	1.5	1.2	1.000	1.00	0
V_{NW}	0							V =	1744
V_W	1744								
VR	1.000								

Configuration Characteristics

Minimum maneuver lanes, N_{WL}	2 lc	Minimum weaving lane changes, LC_{MIN}	1744 lc/h
Interchange density, ID	0.8 int/mi	Weaving lane changes, LC_W	1797 lc/h
Minimum RF lane changes, LC_{RF}	1 lc/pc	Non-weaving lane changes, LC_{NW}	21 lc/h
Minimum FR lane changes, LC_{FR}	1 lc/pc	Total lane changes, LC_{ALL}	1818 lc/h
Minimum RR lane changes, LC_{RR}	lc/pc	Non-weaving vehicle index, I_{NW}	0

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment flow rate, v	1744 pc/h	Weaving intensity factor, W	0.454
Weaving segment capacity, c_w	2400 veh/h	Weaving segment speed, S	42.5 mph
Weaving segment v/c ratio	0.727	Average weaving speed, S_W	42.5 mph
Weaving segment density, D	20.5 pc/mi/ln	Average non-weaving speed, S_{NW}	38.3 mph
Level of Service, LOS	B	Maximum weaving length, L_{MAX}	14232 ft

Notes

a. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments".
b. For volumes that exceed the weaving segment capacity, the level of service is "F".

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-26 WB C-D*
Agency or Company	*Atkins*	From/To	*2245 - Avia Off to Avia EB On*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2018 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*568*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*19*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.913*

Speed Inputs			Calc Speed Adj and FFS		
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f_{LW}		mph
Number of Lanes, N	*2*		f_{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	*55.0*	mph	FFS	*55.0*	mph
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures			Design (N)	
Operational (LOS)			Design (N)	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*346*	pc/h/ln	Design LOS	
			v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h/ln
S	*55.0*	mph	S	mph
D = v_p / S	*6.3*	pc/mi/ln	D = v_p / S	pc/mi/ln
LOS	*A*		Required Number of Lanes, N	

Glossary		Factor Location	
N - Number of lanes	S - Speed	E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
V - Hourly volume	D - Density	E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 11-18	TRD - Page 11-11
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 11-2, 11-3	
DDHV - Directional design hour volume			

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F-2793

BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-26 WB C-D*
Agency or Company	*Atkins*	From/To	*2245 - Avia Off to Avia EB On*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*PM Peak*	Analysis Year	*2018 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*2066*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*4*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.980*

Speed Inputs			Calc Speed Adj and FFS		
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f_{LW}		mph
Number of Lanes, N	*2*		f_{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	*55.0*	mph	FFS	*55.0*	mph
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures			Design (N)	
Operational (LOS)			Design (N)	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1171*	pc/h/ln	Design LOS	
			v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h/ln
S	*55.0*	mph	S	mph
D = v_p / S	*21.3*	pc/mi/ln	D = v_p / S	pc/mi/ln
LOS	*C*		Required Number of Lanes, N	

Glossary		Factor Location	
N - Number of lanes	S - Speed	E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
V - Hourly volume	D - Density	E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 11-18	TRD - Page 11-11
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 11-2, 11-3	
DDHV - Directional design hour volume			

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F-2794

RAMP ADD OR DROP LANE ANALYSIS (MAINLINE <55 MPH)

ATKINS

General Information

Date Performed:	7/25/2014	Freeway/Direction	I-26 WB C-D
Analysis Year	2018 No Action	Junction	WB On from Aviation EB
Analysis Time Period:	AM Peak	Segment ID	2250
Project Description:	Navy Base ICTF		

Inputs

	Mainline Upstream Ramp	Mainline Downstream Ramp	Ramp
Number of Lanes, N	1	1	1
Free-Flow Speed, FFS (mph)	55	55	25
Volume, V (veh/h)	284	304	20
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	19%	19%	25%
%RVs, P_R	0%	0%	0%

Performance Measures

	Upstream of Off-Ramp	Downstream of Off-Ramp	Off-Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.91	0.91	0.89
Demand Flow Rate, v_p (pc/h/ln)	346	370	25
Capacity Flow Rate, c (pc/h/ln)	2,200	2,200	1,900
v/c ratio	0.16	0.17	0.01
Density, D_{MD} (pc/mi/ln)	6.1	6.5	0.4
LOS	A	A	A

Formulas and Reference Material

$$f_{HV} = \frac{1}{1+P_T(E_T-1)+P_R(E_R-1)}$$ HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P}$$ HCM 2010, Equation 11-2

$$D_{MD} = \frac{0.0175*v_f}{N}$$ HCM 2010, Equation 13-26

Ramp Roadways Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

Diverge LOS Thresholds

LOS	Density (pc/mi/ln)
A	≤10
B	>10-20
C	>20-28
D	>28-35
E	>35
F	v/c > 1

Source: HCM 2010, Exhibit 13-2

RAMP ADD OR DROP LANE ANALYSIS (MAINLINE <55 MPH)

ATKINS

General Information

Date Performed:	7/25/2014	Freeway/Direction	I-26 WB C-D
Analysis Year	2018 No Action	Junction	WB On from Aviation EB
Analysis Time Period:	PM Peak	Segment ID	2250
Project Description:	Navy Base ICTF		

Inputs

	Mainline Upstream Ramp	Mainline Downstream Ramp	Ramp
Number of Lanes, N	1	1	1
Free-Flow Speed, FFS (mph)	55	55	25
Volume, V (veh/h)	1,033	1,417	384
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	4%	4%	2%
%RVs, P_R	0%	0%	0%

Performance Measures

	Upstream of Off-Ramp	Downstream of Off-Ramp	Off-Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.98	0.98	0.99
Demand Flow Rate, v_p (pc/h/ln)	1,171	1,606	431
Capacity Flow Rate, c (pc/h/ln)	2,200	2,200	1,900
v/c ratio	0.53	0.73	0.23
Density, D_{MD} (pc/mi/ln)	20.5	28.1	7.5
LOS	C	D	A

Formulas and Reference Material

$$f_{HV} = \frac{1}{1 + P_T(E_T-1)+P_R(E_R-1)}$$ HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P}$$ HCM 2010, Equation 11-2

$$D_{MD} = \frac{0.0175*v_f}{N}$$ HCM 2010, Equation 13-26

Ramp Roadways Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

Diverge LOS Thresholds

LOS	Density (pc/mi/ln)
A	≤10
B	>10-20
C	>20-28
D	>28-35
E	>35
F	v/c > 1

Source: HCM 2010, Exhibit 13-2

RAMP ADD OR DROP LANE ANALYSIS (MAINLINE <55 MPH)

ATKINS

General Information

Date Performed:	7/25/2014	Freeway/Direction	I-26 WB C-D
Analysis Year	2018 No Action	Junction	WB On from Aviation WB
Analysis Time Period:	AM Peak	Segment ID	2260
Project Description:	Navy Base ICTF		

Inputs

	Mainline Upstream Ramp	Mainline Downstream Ramp	Ramp
Number of Lanes, N	1	1	1
Free-Flow Speed, FFS (mph)	55	55	45
Volume, V (veh/h)	304	382	78
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	19%	19%	18%
%RVs, P_R	0%	0%	0%

Performance Measures

	Upstream of Off-Ramp	Downstream of Off-Ramp	Off-Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.91	0.91	0.92
Demand Flow Rate, v_p (pc/h/ln)	370	465	94
Capacity Flow Rate, c (pc/h/ln)	2,200	2,200	2,100
v/c ratio	0.17	0.21	0.04
Density, D_{MD} (pc/mi/ln)	6.5	8.1	1.6
LOS	A	A	A

Formulas and Reference Material

$$f_{HV} = \frac{1}{1+P_T(E_T-1)+P_R(E_R-1)}$$ HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P}$$ HCM 2010, Equation 11-2

$$D_{MD} = \frac{0.0175*v_f}{N}$$ HCM 2010, Equation 13-26

Ramp Roadways Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

Diverge LOS Thresholds

LOS	Density (pc/mi/ln)
A	≤10
B	>10-20
C	>20-28
D	>28-35
E	>35
F	v/c > 1

Source: HCM 2010, Exhibit 13-2

RAMP ADD OR DROP LANE ANALYSIS (MAINLINE <55 MPH)

ATKINS

General Information

Date Performed:	7/25/2014	Freeway/Direction	I-26 WB C-D
Analysis Year	2018 No Action	Junction	WB On from Aviation WB
Analysis Time Period:	PM Peak	Segment ID	2260
Project Description:	Navy Base ICTF		

Inputs

	Mainline Upstream Ramp	Mainline Downstream Ramp	Ramp
Number of Lanes, N	1	1	1
Free-Flow Speed, FFS (mph)	55	55	45
Volume, V (veh/h)	1,417	1,816	399
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	4%	3%	3%
%RVs, P_R	0%	0%	0%

Performance Measures

	Upstream of Off-Ramp	Downstream of Off-Ramp	Off-Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.98	0.99	0.99
Demand Flow Rate, v_p (pc/h/ln)	1,606	2,048	450
Capacity Flow Rate, c (pc/h/ln)	2,200	2,200	2,100
v/c ratio	0.73	0.93	0.21
Density, D_{MD} (pc/mi/ln)	28.1	35.8	7.9
LOS	D	E	A

Formulas and Reference Material

$$f_{HV} = \frac{1}{1+P_T(E_T-1)+P_R(E_R-1)}$$ HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P}$$ HCM 2010, Equation 11-2

$$D_{MD} = \frac{0.0175*v_f}{N}$$ HCM 2010, Equation 13-26

Ramp Roadways Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

Diverge LOS Thresholds

LOS	Density (pc/mi/ln)
A	≤10
B	>10-20
C	>20-28
D	>28-35
E	>35
F	v/c > 1

Source: HCM 2010, Exhibit 13-2

FREEWAY RAMP ADD OR DROP LANE ANALYSIS

ATKINS

General Information

Date Performed:	7/25/2014	Freeway/Direction	I-26 WB
Analysis Year	2018 No Action	Junction	From Rem/Aviation C-D
Analysis Time Period:	AM Peak	Segment ID	2270
Project Description:	Navy Base ICTF		

Inputs

	Freeway Upstream of Ramp	Freeway Downstream of Ramp	Ramp
Number of Lanes, N	4	5	1
Free-Flow Speed, FFS (mph)	60	60	55
Volume, V (veh/h)	4,362	4,744	382
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	15%	15%	19%
%RVs, P_R	0%	0%	0%

Performance Measures

	Freeway Upstream Ramp	Freeway Downstream Ramp	Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.93	0.93	0.91
Demand Flow Rate, v_p (pc/h/ln)	1,303	1,133	465
Capacity Flow Rate, c (pc/h/ln)	2,300	2,300	2,200
v/c ratio	0.57	0.49	0.21
Density, D_{MD} (pc/mi/ln)	22.8	19.8	8.1
LOS	C	B	A

Formulas and Reference Material

$$f_{HV} = \frac{1}{1 + P_T(E_T-1)+P_R(E_R-1)}$$ HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P}$$ HCM 2010, Equation 11-2

$$D_{MD} = \frac{0.0175*v_f}{N}$$ HCM 2010, Equation 13-26

Basic Freeway Segments Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
75	2,400
70	2,400
65	2,350
60	2,300
55	2,250

Source: HCM 2010, Exhibit 11-17

Ramp Roadways Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

Diverge LOS Thresholds

LOS	Density (pc/mi/ln)
A	≤10
B	>10-20
C	>20-28
D	>28-35
E	>35
F	v/c > 1

Source: HCM 2010, Exhibit 13-2

FREEWAY RAMP ADD OR DROP LANE ANALYSIS

ATKINS

General Information

Date Performed:	7/25/2014	Freeway/Direction	I-26 WB
Analysis Year	2018 No Action	Junction	From Rem/Aviation C-D
Analysis Time Period:	PM Peak	Segment ID	2270
Project Description:	Navy Base ICTF		

Inputs

	Freeway Upstream of Ramp	Freeway Downstream of Ramp	Ramp
Number of Lanes, N	4	5	1
Free-Flow Speed, FFS (mph)	60	60	55
Volume, V (veh/h)	7,236	9,052	1,816
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	12%	11%	3%
%RVs, P_R	0%	0%	0%

Performance Measures

	Freeway Upstream Ramp	Freeway Downstream Ramp	Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.94	0.95	0.99
Demand Flow Rate, v_p (pc/h/ln)	2,131	2,122	2,048
Capacity Flow Rate, c (pc/h/ln)	2,300	2,300	2,200
v/c ratio	0.93	0.92	0.93
Density, D_{MD} (pc/mi/ln)	37.3	37.1	35.8
LOS	E	E	E

Formulas and Reference Material

$$f_{HV} = \frac{1}{1 + P_T(E_T-1)+P_R(E_R-1)}$$ HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P}$$ HCM 2010, Equation 11-2

$$D_{MD} = \frac{0.0175*v_f}{N}$$ HCM 2010, Equation 13-26

Basic Freeway Segments Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
75	2,400
70	2,400
65	2,350
60	2,300
55	2,250

Source: HCM 2010, Exhibit 11-17

Ramp Roadways Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

Diverge LOS Thresholds

LOS	Density (pc/mi/ln)
A	≤10
B	>10-20
C	>20-28
D	>28-35
E	>35
F	v/c > 1

Source: HCM 2010, Exhibit 13-2

Appendix E
Traffic Analysis Worksheets

2018 Opening Year

No Action Alternative

Interstate 526

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-526 EB
Agency or Company	Atkins	Junction	3010-EB Off to PaulCantrell EB
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2018 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Freeway Number of Lanes, N	2	Downstream Adj Ramp	
☐ Yes	☐ On	Ramp Number of Lanes, N	1	☐ Yes	☐ On
☑ No	☐ Off	Acceleration Lane Length, L_A		☑ No	☐ Off
L_{up} =	ft	Deceleration Lane Length L_D	340	L_{down} =	ft
V_u =	veh/h	Freeway Volume, V_F	2647	V_D =	veh/h
		Ramp Volume, V_R	28		
		Freeway Free-Flow Speed, S_{FF}	60.0		
		Ramp Free-Flow Speed, S_{FR}	45.0		

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	2647	0.90	Level	3	0	0.985	1.00	2985
Ramp	28	0.90	Level	36	0	0.847	1.00	37
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 1.000 using Equation (Exhibit 13-7)

V_{12} = 2985 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	2985	Exhibit 13-8	4600	No
$V_{FO} = V_F - V_R$	2948	Exhibit 13-8	4600	No
V_R	37	Exhibit 13-10	2100	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	2985	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = 26.9 (pc/mi/ln)

LOS = C (Exhibit 13-2)

Speed Determination

D_s = 0.301 (Exhibit 13-12)

S_R= 54.6 mph (Exhibit 13-12)

S_0= N/A mph (Exhibit 13-12)

S = 54.6 mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-526 EB
Agency or Company	Atkins	Junction	3010-EB Off to PaulCantrell EB
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2018 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Number of Lanes, N	2	Downstream Adj Ramp	
☐ Yes	☐ On	Acceleration Lane Length, L_A		☐ Yes	☐ On
☑ No	☐ Off	Deceleration Lane Length L_D	340	☑ No	☐ Off
L_{up} =	ft	Freeway Volume, V_F	2532	L_{down} =	ft
		Ramp Volume, V_R	55		
V_u =	veh/h	Freeway Free-Flow Speed, S_{FF}	60.0	V_D =	veh/h
		Ramp Free-Flow Speed, S_{FR}	45.0		

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	2532	0.90	Level	3	0	0.985	1.00	2856
Ramp	55	0.90	Level	15	0	0.930	1.00	66
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 1.000 using Equation (Exhibit 13-7)

V_{12} = 2856 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	2856	Exhibit 13-8	4600	No
$V_{FO} = V_F - V_R$	2790	Exhibit 13-8	4600	No
V_R	66	Exhibit 13-10	2100	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	2856	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = 25.8 (pc/mi/ln)

LOS = C (Exhibit 13-2)

Speed Determination

D_s = 0.304 (Exhibit 13-12)

S_R= 54.5 mph (Exhibit 13-12)

S_0= N/A mph (Exhibit 13-12)

S = 54.5 mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-526 EB
Agency or Company	Atkins	Junction	3020-EB Off to PaulCantrell WB
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2018 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Number of Lanes, N	2	Downstream Adj Ramp	
☐ Yes	☐ On	Acceleration Lane Length, L_A		☐ Yes	☐ On
☑ No	☐ Off	Deceleration Lane Length L_D	600	☑ No	☐ Off
L_{up} =	ft	Freeway Volume, V_F	2619	L_{down} =	ft
		Ramp Volume, V_R	174		
		Freeway Free-Flow Speed, S_{FF}	60.0		
V_u =	veh/h	Ramp Free-Flow Speed, S_{FR}	25.0	V_D =	veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	2619	0.90	Level	10	0	0.952	1.00	3056
Ramp	174	0.90	Level	7	0	0.966	1.00	200
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 1.000 using Equation (Exhibit 13-7)

V_{12} = 3056 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	3056	Exhibit 13-8	4600	No
$V_{FO} = V_F - V_R$	2856	Exhibit 13-8	4600	No
V_R	200	Exhibit 13-10	1900	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	3056	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = 25.1 (pc/mi/ln)

LOS = C (Exhibit 13-2)

Speed Determination

D_s = 0.576 (Exhibit 13-12)

S_R= 49.6 mph (Exhibit 13-12)

S_0= N/A mph (Exhibit 13-12)

S = 49.6 mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-526 EB
Agency or Company	Atkins	Junction	3020-EB Off to PaulCantrell WB
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2018 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Number of Lanes, N	2	Downstream Adj Ramp	
☐ Yes	☐ On	Acceleration Lane Length, L_A		☐ Yes	☐ On
☑ No	☐ Off	Deceleration Lane Length L_D	600	☑ No	☐ Off
L_{up} =	ft	Freeway Volume, V_F	2477	L_{down} =	ft
V_u =	veh/h	Ramp Volume, V_R	574	V_D =	veh/h
		Freeway Free-Flow Speed, S_{FF}	60.0		
		Ramp Free-Flow Speed, S_{FR}	25.0		

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	2477	0.90	Level	8	0	0.962	1.00	2862
Ramp	574	0.90	Level	2	0	0.990	1.00	644
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 1.000 using Equation (Exhibit 13-7)

V_{12} = 2862 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	2862	Exhibit 13-8	4600	No
$V_{FO} = V_F - V_R$	2218	Exhibit 13-8	4600	No
V_R	644	Exhibit 13-10	1900	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	2862	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = 23.5 (pc/mi/ln)

LOS = C (Exhibit 13-2)

Speed Determination

D_s = 0.616 (Exhibit 13-12)

S_R= 48.9 mph (Exhibit 13-12)

S_0= N/A mph (Exhibit 13-12)

S = 48.9 mph (Exhibit 13-13)

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-526 EB*
Agency or Company	*Atkins*	From/To	*3025- PaulC WB Off to PaulC On*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2018 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*2445*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*10*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.952*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*60.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*60.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1426*	pc/h/ln
S	*60.0*	mph
D = v_p / S	*23.8*	pc/mi/ln
LOS	*C*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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F-2806

BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-526 EB*
Agency or Company	*Atkins*	From/To	*3025- PaulC WB Off to PaulC On*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*PM Peak*	Analysis Year	*2018 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*1903*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*8*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.962*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*60.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*60.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1100*	pc/h/ln
S	*60.0*	mph
D = v_p / S	*18.3*	pc/mi/ln
LOS	*C*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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F-2807

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-526 EB
Agency or Company	Atkins	Junction	3030-EB On from Paul Cantrell
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2018 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Freeway Number of Lanes, N: 2	☐ Yes ☐ On
☑ No ☐ Off	Ramp Number of Lanes, N: 1	☑ No ☐ Off
L_{up} = ft	Acceleration Lane Length, L_A: 850	L_{down} = ft
V_u = veh/h	Deceleration Lane Length L_D:	V_D = veh/h
	Freeway Volume, V_F: 2445	
	Ramp Volume, V_R: 1653	
	Freeway Free-Flow Speed, S_{FF}: 60.0	
	Ramp Free-Flow Speed, S_{FR}: 45.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	2445	0.90	Level	10	0	0.952	1.00	2853
Ramp	1653	0.90	Level	19	0	0.913	1.00	2011
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 1.000 using Equation (Exhibit 13-6)

V_{12} = 2853 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	4864	Exhibit 13-8		Yes

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	4864	Exhibit 13-8	4600:All	Yes

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = 37.2 (pc/mi/ln)

LOS = F (Exhibit 13-2)

Speed Determination

M_S = 0.750 (Exibit 13-11)

S_R= 46.5 mph (Exhibit 13-11)

S_0= N/A mph (Exhibit 13-11)

S = 46.5 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-526 EB
Agency or Company	Atkins	Junction	3030-EB On from Paul Cantrell
Date Performed	4/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2018 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Freeway Number of Lanes, N: 2	☐ Yes ☐ On
☑ No ☐ Off	Ramp Number of Lanes, N: 1	☑ No ☐ Off
L_{up} = ft	Acceleration Lane Length, L_A: 850	L_{down} = ft
V_u = veh/h	Deceleration Lane Length L_D:	V_D = veh/h
	Freeway Volume, V_F: 1903	
	Ramp Volume, V_R: 1449	
	Freeway Free-Flow Speed, S_{FF}: 60.0	
	Ramp Free-Flow Speed, S_{FR}: 45.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	1903	0.90	Level	8	0	0.962	1.00	2199
Ramp	1449	0.90	Level	18	0	0.917	1.00	1755
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 1.000 using Equation (Exhibit 13-6)

V_{12} = 2199 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	3954	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	3954	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = 30.2 (pc/mi/ln)

LOS = D (Exhibit 13-2)

Speed Determination

M_S = 0.448 (Exibit 13-11)

S_R= 51.9 mph (Exhibit 13-11)

S_0= N/A mph (Exhibit 13-11)

S = 51.9 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-526 EB*
Agency or Company	*Atkins*	From/To	*3040 - Paul Cantrell to Leeds*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2018 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*4098*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*10*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.952*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*60.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*60.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*2391*	pc/h/ln
S	*48.6*	mph
D = v_p / S	*49.2*	pc/mi/ln
LOS	*F*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-526 EB*
Agency or Company	*Atkins*	From/To	*3040 - Paul Cantrell to Leeds*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*PM Peak*	Analysis Year	*2018 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*3352*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*8*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.962*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*60.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*60.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1937*	pc/h/ln
S	*57.9*	mph
D = v_p / S	*33.4*	pc/mi/ln
LOS	*D*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-526 EB
Agency or Company	Atkins	Junction	3050-EB Off to Leeds
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2018 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Number of Lanes, N	2	Downstream Adj Ramp	
☐ Yes	☐ On	Acceleration Lane Length, L_A		☐ Yes	☐ On
☑ No	☐ Off	Deceleration Lane Length L_D	325	☑ No	☐ Off
L_{up} =	ft	Freeway Volume, V_F	4098	L_{down} =	ft
V_u =	veh/h	Ramp Volume, V_R	678	V_D =	veh/h
		Freeway Free-Flow Speed, S_{FF}	60.0		
		Ramp Free-Flow Speed, S_{FR}	45.0		

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	4098	0.90	Level	10	0	0.952	1.00	4781
Ramp	678	0.90	Level	8	0	0.962	1.00	783
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 1.000 using Equation (Exhibit 13-7)

V_{12} = 4781 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	4781	Exhibit 13-8	4600	Yes
$V_{FO} = V_F - V_R$	3998	Exhibit 13-8	4600	No
V_R	783	Exhibit 13-10	2100	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	4781	Exhibit 13-8	4400:All	Yes

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = 42.4 (pc/mi/ln)

LOS = F (Exhibit 13-2)

Speed Determination

D_s = 0.368 (Exhibit 13-12)

S_R= 53.4 mph (Exhibit 13-12)

S_0= N/A mph (Exhibit 13-12)

S = 53.4 mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-526 EB
Agency or Company	Atkins	Junction	3050-EB Off to Leeds
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2018 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Number of Lanes, N	2	Downstream Adj Ramp	
☐ Yes	☐ On	Acceleration Lane Length, L_A		☐ Yes	☐ On
☑ No	☐ Off	Deceleration Lane Length L_D	325	☑ No	☐ Off
L_{up} =	ft	Freeway Volume, V_F	3352	L_{down} =	ft
V_u =	veh/h	Ramp Volume, V_R	320	V_D =	veh/h
		Freeway Free-Flow Speed, S_{FF}	60.0		
		Ramp Free-Flow Speed, S_{FR}	45.0		

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	3352	0.90	Level	8	0	0.962	1.00	3873
Ramp	320	0.90	Level	15	0	0.930	1.00	382
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 1.000 using Equation (Exhibit 13-7)

V_{12} = 3873 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	3873	Exhibit 13-8	4600	No
$V_{FO} = V_F - V_R$	3491	Exhibit 13-8	4600	No
V_R	382	Exhibit 13-10	2100	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	3873	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = 34.6 (pc/mi/ln)

LOS = D (Exhibit 13-2)

Speed Determination

D_s = 0.332 (Exhibit 13-12)

S_R= 54.0 mph (Exhibit 13-12)

S_0= N/A mph (Exhibit 13-12)

S = 54.0 mph (Exhibit 13-13)

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-526 EB*
Agency or Company	*Atkins*	From/To	*3055 - Leeds Off to Leeds On*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2018 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*3420*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*10*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.952*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*60.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*60.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1995*	pc/h/ln
S	*57.2*	mph
D = v_p / S	*34.9*	pc/mi/ln
LOS	*D*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-526 EB*
Agency or Company	*Atkins*	From/To	*3055 - Leeds Off to Leeds On*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*PM Peak*	Analysis Year	*2018 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*3032*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*8*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.962*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*60.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*60.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1752*	pc/h/ln
S	*59.6*	mph
D = v_p / S	*29.4*	pc/mi/ln
LOS	*D*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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Navy Base ICTF

FREEWAY WEAVING WORKSHEET

General Information

Analyst	AJR
Agency/Company	Atkins
Date Performed	7/25/2014
Analysis Time Period	AM Peak

Site Information

Freeway/Dir of Travel	I-526 EB
Weaving Segment Location	3060 - Leeds to Dorchester
Analysis Year	2018 No Action

Project Description *Navy Base ICTF*

Inputs

Weaving configuration	One-Sided	Segment type	Freeway
Weaving number of lanes, N	3	Freeway minimum speed, S_{MIN}	15
Weaving segment length, L_S	2020ft	Freeway maximum capacity, C_{IFL}	2300
Freeway free-flow speed, FFS	60 mph	Terrain type	Level

Conversions to pc/h Under Base Conditions

	V (veh/h)	PHF	Truck (%)	RV (%)	E_T	E_R	f_{HV}	f_p	v (pc/h)
V_{FF}	3118	0.90	8	0	1.5	1.2	0.962	1.00	3603
V_{RF}	231	0.90	8	0	1.5	1.2	0.962	1.00	267
V_{FR}	302	0.90	11	0	1.5	1.2	0.948	1.00	354
V_{RR}	22	0.90	11	0	1.5	1.2	0.948	1.00	26
V_{NW}	3629							V =	4250
V_W	621								
VR	0.146								

Configuration Characteristics

Minimum maneuver lanes, N_{WL}	2 lc	Minimum weaving lane changes, LC_{MIN}	621 lc/h
Interchange density, ID	1.0 int/mi	Weaving lane changes, LC_W	874 lc/h
Minimum RF lane changes, LC_{RF}	1 lc/pc	Non-weaving lane changes, LC_{NW}	1265 lc/h
Minimum FR lane changes, LC_{FR}	1 lc/pc	Total lane changes, LC_{ALL}	2139 lc/h
Minimum RR lane changes, LC_{RR}	lc/pc	Non-weaving vehicle index, I_{NW}	733

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment flow rate, v	4250 pc/h	Weaving intensity factor, W	0.236
Weaving segment capacity, c_w	6199 veh/h	Weaving segment speed, S	49.1 mph
Weaving segment v/c ratio	0.659	Average weaving speed, S_W	51.4 mph
Weaving segment density, D	28.9 pc/mi/ln	Average non-weaving speed, S_{NW}	48.7 mph
Level of Service, LOS	D	Maximum weaving length, L_{MAX}	3993 ft

Notes

a. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments".
b. For volumes that exceed the weaving segment capacity, the level of service is "F".

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Navy Base ICTF

FREEWAY WEAVING WORKSHEET

General Information

Analyst	AJR
Agency/Company	Atkins
Date Performed	7/25/2014
Analysis Time Period	PM Peak

Site Information

Freeway/Dir of Travel	I-526 EB
Weaving Segment Location	3060 - Leeds to Dorchester
Analysis Year	2018 No Action

Project Description *Navy Base ICTF*

Inputs

Weaving configuration	One-Sided	Segment type	Freeway
Weaving number of lanes, N	3	Freeway minimum speed, S_{MIN}	15
Weaving segment length, L_S	2020ft	Freeway maximum capacity, C_{IFL}	2300
Freeway free-flow speed, FFS	60 mph	Terrain type	Level

Conversions to pc/h Under Base Conditions

	V (veh/h)	PHF	Truck (%)	RV (%)	E_T	E_R	f_{HV}	f_p	v (pc/h)
V_{FF}	2674	0.90	7	0	1.5	1.2	0.966	1.00	3075
V_{RF}	809	0.90	7	0	1.5	1.2	0.966	1.00	930
V_{FR}	358	0.90	7	0	1.5	1.2	0.966	1.00	412
V_{RR}	108	0.90	7	0	1.5	1.2	0.966	1.00	124
V_{NW}	3199							V =	4541
V_W	1342								
VR	0.296								

Configuration Characteristics

Minimum maneuver lanes, N_{WL}	2 lc	Minimum weaving lane changes, LC_{MIN}	1342 lc/h
Interchange density, ID	1.0 int/mi	Weaving lane changes, LC_W	1595 lc/h
Minimum RF lane changes, LC_{RF}	1 lc/pc	Non-weaving lane changes, LC_{NW}	1176 lc/h
Minimum FR lane changes, LC_{FR}	1 lc/pc	Total lane changes, LC_{ALL}	2771 lc/h
Minimum RR lane changes, LC_{RR}	lc/pc	Non-weaving vehicle index, I_{NW}	646

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment flow rate, v	4541 pc/h	Weaving intensity factor, W	0.290
Weaving segment capacity, c_w	5887 veh/h	Weaving segment speed, S	44.9 mph
Weaving segment v/c ratio	0.745	Average weaving speed, S_W	49.9 mph
Weaving segment density, D	33.7 pc/mi/ln	Average non-weaving speed, S_{NW}	43.1 mph
Level of Service, LOS	D	Maximum weaving length, L_{MAX}	5536 ft

Notes

a. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments".
b. For volumes that exceed the weaving segment capacity, the level of service is "F".

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-526 EB*
Agency or Company	*Atkins*	From/To	*3065-Dorches Off to Dorches On*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2018 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*3349*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*9*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.957*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*60.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*60.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1944*	pc/h/ln
S	*57.9*	mph
D = v_p / S	*33.6*	pc/mi/ln
LOS	*D*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-526 EB*
Agency or Company	*Atkins*	From/To	*3065-Dorches Off to Dorches On*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*PM Peak*	Analysis Year	*2018 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*3483*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*8*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.962*

Speed Inputs			Calc Speed Adj and FFS		
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f_{LW}		mph
Number of Lanes, N	*2*		f_{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	*60.0*	mph	FFS	*60.0*	mph
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures			Design (N)	
Operational (LOS)			Design (N)	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*2012*	pc/h/ln	Design LOS	
			v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h/ln
S	*56.9*	mph	S	mph
D = v_p / S	*35.3*	pc/mi/ln	D = v_p / S	pc/mi/ln
LOS	*E*		Required Number of Lanes, N	

Glossary		Factor Location	
N - Number of lanes	S - Speed	E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
V - Hourly volume	D - Density	E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 11-18	TRD - Page 11-11
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 11-2, 11-3	
DDHV - Directional design hour volume			

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Navy Base ICTF

FREEWAY WEAVING WORKSHEET

General Information

Analyst	AJR
Agency/Company	Atkins
Date Performed	7/25/2014
Analysis Time Period	AM Peak

Site Information

Freeway/Dir of Travel	I-526 EB
Weaving Segment Location	3070 - Dorchester to Montague
Analysis Year	2018 No Action

Project Description *Navy Base ICTF*

Inputs

Weaving configuration	One-Sided	Segment type	Freeway
Weaving number of lanes, N	3	Freeway minimum speed, S_{MIN}	15
Weaving segment length, L_S	1515ft	Freeway maximum capacity, C_{IFL}	2300
Freeway free-flow speed, FFS	60 mph	Terrain type	Level

Conversions to pc/h Under Base Conditions

	V (veh/h)	PHF	Truck (%)	RV (%)	E_T	E_R	f_{HV}	f_p	v (pc/h)
V_{FF}	2745	0.90	9	0	1.5	1.2	0.957	1.00	3187
V_{RF}	545	0.90	20	0	1.5	1.2	0.909	1.00	666
V_{FR}	604	0.90	10	0	1.5	1.2	0.952	1.00	705
V_{RR}	120	0.90	20	0	1.5	1.2	0.909	1.00	147
V_{NW}	3334							V =	4705
V_W	1371								
VR	0.291								

Configuration Characteristics

Minimum maneuver lanes, N_{WL}	2 lc	Minimum weaving lane changes, LC_{MIN}	1371 lc/h
Interchange density, ID	0.8 int/mi	Weaving lane changes, LC_W	1567 lc/h
Minimum RF lane changes, LC_{RF}	1 lc/pc	Non-weaving lane changes, LC_{NW}	930 lc/h
Minimum FR lane changes, LC_{FR}	1 lc/pc	Total lane changes, LC_{ALL}	2497 lc/h
Minimum RR lane changes, LC_{RR}	lc/pc	Non-weaving vehicle index, I_{NW}	404

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment flow rate, v	4705 pc/h	Weaving intensity factor, W	0.335
Weaving segment capacity, c_w	5730 veh/h	Weaving segment speed, S	44.2 mph
Weaving segment v/c ratio	0.786	Average weaving speed, S_W	48.7 mph
Weaving segment density, D	35.5 pc/mi/ln	Average non-weaving speed, S_{NW}	42.6 mph
Level of Service, LOS	E	Maximum weaving length, L_{MAX}	5492 ft

Notes

a. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments".
b. For volumes that exceed the weaving segment capacity, the level of service is "F".

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Navy Base ICTF

FREEWAY WEAVING WORKSHEET

General Information

Analyst	AJR
Agency/Company	Atkins
Date Performed	7/25/2014
Analysis Time Period	PM Peak

Site Information

Freeway/Dir of Travel	I-526 EB
Weaving Segment Location	3070 - Dorchester to Montague
Analysis Year	2018 No Action

Project Description *Navy Base ICTF*

Inputs

Weaving configuration	One-Sided	Segment type	Freeway
Weaving number of lanes, N	3	Freeway minimum speed, S_{MIN}	15
Weaving segment length, L_S	1515ft	Freeway maximum capacity, C_{IFL}	2300
Freeway free-flow speed, FFS	60 mph	Terrain type	Level

Conversions to pc/h Under Base Conditions

	V (veh/h)	PHF	Truck (%)	RV (%)	E_T	E_R	f_{HV}	f_p	v (pc/h)
V_{FF}	2707	0.90	8	0	1.5	1.2	0.962	1.00	3128
V_{RF}	780	0.90	11	0	1.5	1.2	0.948	1.00	914
V_{FR}	776	0.90	8	0	1.5	1.2	0.962	1.00	897
V_{RR}	223	0.90	11	0	1.5	1.2	0.948	1.00	261
V_{NW}	3389							V =	5200
V_W	1811								
VR	0.348								

Configuration Characteristics

Minimum maneuver lanes, N_{WL}	2 lc	Minimum weaving lane changes, LC_{MIN}	1811 lc/h
Interchange density, ID	0.8 int/mi	Weaving lane changes, LC_W	2007 lc/h
Minimum RF lane changes, LC_{RF}	1 lc/pc	Non-weaving lane changes, LC_{NW}	941 lc/h
Minimum FR lane changes, LC_{FR}	1 lc/pc	Total lane changes, LC_{ALL}	2948 lc/h
Minimum RR lane changes, LC_{RR}	lc/pc	Non-weaving vehicle index, I_{NW}	411

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment flow rate, v	5200 pc/h	Weaving intensity factor, W	0.382
Weaving segment capacity, c_w	5622 veh/h	Weaving segment speed, S	41.3 mph
Weaving segment v/c ratio	0.889	Average weaving speed, S_W	47.6 mph
Weaving segment density, D	41.9 pc/mi/ln	Average non-weaving speed, S_{NW}	38.6 mph
Level of Service, LOS	E	Maximum weaving length, L_{MAX}	6107 ft

Notes

a. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments".
b. For volumes that exceed the weaving segment capacity, the level of service is "F".

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-526 EB*
Agency or Company	*Atkins*	From/To	*3080-Montague to International*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2018 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*3290*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*9*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.957*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*60.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*60.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1910*	pc/h/ln
S	*58.3*	mph
D = v_p / S	*32.8*	pc/mi/ln
LOS	*D*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-526 EB*
Agency or Company	*Atkins*	From/To	*3080-Montague to International*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*PM Peak*	Analysis Year	*2018 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*3487*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*9*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.957*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*60.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*60.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*2024*	pc/h/ln
S	*56.7*	mph
D = v_p / S	*35.7*	pc/mi/ln
LOS	*E*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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F-2823

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-526 EB
Agency or Company	Atkins	Junction	3090-EB Off to InternationalWB
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2018 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Number of Lanes, N: 2	☐ Yes ☐ On
☑ No ☐ Off	Acceleration Lane Length, L_A	☑ No ☐ Off
L_{up} = ft	Deceleration Lane Length L_D: 700	L_{down} = ft
V_u = veh/h	Freeway Volume, V_F: 3290	V_D = veh/h
	Ramp Volume, V_R: 655	
	Freeway Free-Flow Speed, S_{FF}: 60.0	
	Ramp Free-Flow Speed, S_{FR}: 25.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	3290	0.90	Level	9	0	0.957	1.00	3820
Ramp	655	0.90	Level	8	0	0.962	1.00	757
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 1.000 using Equation (Exhibit 13-7)

V_{12} = 3820 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	3820	Exhibit 13-8	4600	No
$V_{FO} = V_F - V_R$	3063	Exhibit 13-8	4600	No
V_R	757	Exhibit 13-10	1900	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	3820	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = 30.8 (pc/mi/ln)

LOS = D (Exhibit 13-2)

Speed Determination

D_s = 0.626 (Exhibit 13-12)

S_R= 48.7 mph (Exhibit 13-12)

S_0= N/A mph (Exhibit 13-12)

S = 48.7 mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-526 EB
Agency or Company	Atkins	Junction	3090-EB Off to InternationalWB
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2018 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Number of Lanes, N	2	Downstream Adj Ramp	
☐ Yes	☐ On	Acceleration Lane Length, L_A		☐ Yes	☐ On
☑ No	☐ Off	Deceleration Lane Length L_D	700	☑ No	☐ Off
L_{up} =	ft	Freeway Volume, V_F	3487	L_{down} =	ft
V_u =	veh/h	Ramp Volume, V_R	672	V_D =	veh/h
		Freeway Free-Flow Speed, S_{FF}	60.0		
		Ramp Free-Flow Speed, S_{FR}	25.0		

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	3487	0.90	Level	9	0	0.957	1.00	4049
Ramp	672	0.90	Level	7	0	0.966	1.00	773
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 1.000 using Equation (Exhibit 13-7)

V_{12} = 4049 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	4049	Exhibit 13-8	4600	No
$V_{FO} = V_F - V_R$	3276	Exhibit 13-8	4600	No
V_R	773	Exhibit 13-10	1900	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	4049	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = 32.8 (pc/mi/ln)

LOS = D (Exhibit 13-2)

Speed Determination

D_s = 0.628 (Exhibit 13-12)

S_R= 48.7 mph (Exhibit 13-12)

S_0= N/A mph (Exhibit 13-12)

S = 48.7 mph (Exhibit 13-13)

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-526 EB*
Agency or Company	*Atkins*	From/To	*3095- Inter WB Off to Inter On*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2018 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*2635*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*10*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.952*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*60.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*60.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1537*	pc/h/ln
S	*60.0*	mph
D = v_p / S	*25.6*	pc/mi/ln
LOS	*C*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-526 EB*
Agency or Company	*Atkins*	From/To	*3095- Inter WB Off to Inter On*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*PM Peak*	Analysis Year	*2018 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*2815*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*8*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.962*

Speed Inputs			Calc Speed Adj and FFS		
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f_{LW}		mph
Number of Lanes, N	*2*		f_{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	*60.0*	mph	FFS	*60.0*	mph
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures			Design (N)	
Operational (LOS)			Design (N)	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1626*	pc/h/ln	Design LOS	
			v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h/ln
S	*60.0*	mph	S	mph
D = v_p / S	*27.1*	pc/mi/ln	D = v_p / S	pc/mi/ln
LOS	*D*		Required Number of Lanes, N	

Glossary		Factor Location	
N - Number of lanes	S - Speed	E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
V - Hourly volume	D - Density	E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 11-18	TRD - Page 11-11
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 11-2, 11-3	
DDHV - Directional design hour volume			

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F-2827

Navy Base ICTF

FREEWAY WEAVING WORKSHEET

General Information

Analyst	AJR
Agency/Company	Atkins
Date Performed	7/25/2014
Analysis Time Period	AM Peak

Site Information

Freeway/Dir of Travel	I-526 EB
Weaving Segment Location	3100 - International to I-26
Analysis Year	2018 No Action

Project Description *Navy Base ICTF*

Inputs

Weaving configuration	One-Sided	Segment type	Freeway
Weaving number of lanes, N	3	Freeway minimum speed, S_{MIN}	15
Weaving segment length, L_S	2025ft	Freeway maximum capacity, C_{IFL}	2250
Freeway free-flow speed, FFS	55 mph	Terrain type	Level

Conversions to pc/h Under Base Conditions

	V (veh/h)	PHF	Truck (%)	RV (%)	E_T	E_R	f_{HV}	f_p	v (pc/h)
V_{FF}	1199	0.90	10	0	1.5	1.2	0.952	1.00	1399
V_{RF}	573	0.90	10	0	1.5	1.2	0.952	1.00	669
V_{FR}	1436	0.90	11	0	1.5	1.2	0.948	1.00	1683
V_{RR}	687	0.90	11	0	1.5	1.2	0.948	1.00	805
V_{NW}	2204							V =	4556
V_W	2352								
VR	0.516								

Configuration Characteristics

Minimum maneuver lanes, N_{WL}	3 lc	Minimum weaving lane changes, LC_{MIN}	669 lc/h
Interchange density, ID	1.0 int/mi	Weaving lane changes, LC_W	923 lc/h
Minimum RF lane changes, LC_{RF}	1 lc/pc	Non-weaving lane changes, LC_{NW}	974 lc/h
Minimum FR lane changes, LC_{FR}	0 lc/pc	Total lane changes, LC_{ALL}	1897 lc/h
Minimum RR lane changes, LC_{RR}	lc/pc	Non-weaving vehicle index, I_{NW}	446

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment flow rate, v	4556 pc/h	Weaving intensity factor, W	0.215
Weaving segment capacity, c_w	5460 veh/h	Weaving segment speed, S	45.4 mph
Weaving segment v/c ratio	0.795	Average weaving speed, S_W	47.9 mph
Weaving segment density, D	33.5 pc/mi/ln	Average non-weaving speed, S_{NW}	42.9 mph
Level of Service, LOS	D	Maximum weaving length, L_{MAX}	6451 ft

Notes

a. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments".
b. For volumes that exceed the weaving segment capacity, the level of service is "F".

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Navy Base ICTF

FREEWAY WEAVING WORKSHEET

General Information

Analyst	AJR
Agency/Company	Atkins
Date Performed	7/25/2014
Analysis Time Period	PM Peak

Site Information

Freeway/Dir of Travel	I-526 EB
Weaving Segment Location	3100 - International to I-26
Analysis Year	2018 No Action

Project Description *Navy Base ICTF*

Inputs

Weaving configuration	One-Sided	Segment type	Freeway
Weaving number of lanes, N	3	Freeway minimum speed, S_{MIN}	15
Weaving segment length, L_S	2025ft	Freeway maximum capacity, C_{IFL}	2250
Freeway free-flow speed, FFS	55 mph	Terrain type	Level

Conversions to pc/h Under Base Conditions

	V (veh/h)	PHF	Truck (%)	RV (%)	E_T	E_R	f_{HV}	f_p	v (pc/h)
V_{FF}	1343	0.90	8	0	1.5	1.2	0.962	1.00	1552
V_{RF}	896	0.90	8	0	1.5	1.2	0.962	1.00	1035
V_{FR}	1472	0.90	8	0	1.5	1.2	0.962	1.00	1701
V_{RR}	981	0.90	8	0	1.5	1.2	0.962	1.00	1134
V_{NW}	2686							V =	5422
V_W	2736								
VR	0.505								

Configuration Characteristics

Minimum maneuver lanes, N_{WL}	3 lc	Minimum weaving lane changes, LC_{MIN}	1035 lc/h
Interchange density, ID	1.0 int/mi	Weaving lane changes, LC_W	1289 lc/h
Minimum RF lane changes, LC_{RF}	1 lc/pc	Non-weaving lane changes, LC_{NW}	1073 lc/h
Minimum FR lane changes, LC_{FR}	0 lc/pc	Total lane changes, LC_{ALL}	2362 lc/h
Minimum RR lane changes, LC_{RR}	lc/pc	Non-weaving vehicle index, I_{NW}	544

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment flow rate, v	5422 pc/h	Weaving intensity factor, W	0.255
Weaving segment capacity, c_w	5544 veh/h	Weaving segment speed, S	42.5 mph
Weaving segment v/c ratio	0.940	Average weaving speed, S_W	46.9 mph
Weaving segment density, D	42.5 pc/mi/ln	Average non-weaving speed, S_{NW}	38.9 mph
Level of Service, LOS	E	Maximum weaving length, L_{MAX}	6314 ft

Notes

a. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments".
b. For volumes that exceed the weaving segment capacity, the level of service is "F".

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-526 EB*
Agency or Company	*Atkins*	From/To	*3105-I-26 Off to I-26 EB CD On*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2018 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*1772*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*17*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.922*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*55.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*55.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1068*	pc/h/ln
S	*55.0*	mph
D = v_p / S	*19.4*	pc/mi/ln
LOS	*C*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-526 EB*
Agency or Company	*Atkins*	From/To	*3105-I-26 Off to I-26 EB CD On*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*PM Peak*	Analysis Year	*2018 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*2239*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*15*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.930*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*55.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*55.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1337*	pc/h/ln
S	*55.0*	mph
D = v_p / S	*24.3*	pc/mi/ln
LOS	*C*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-526 EB
Agency or Company	Atkins	Junction	3110-EB On from I-26 EB
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2018 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Number of Lanes, N: 2	☐ Yes ☐ On
☑ No ☐ Off	Acceleration Lane Length, L_A: 625	☑ No ☐ Off
L_{up} = ft	Deceleration Lane Length L_D:	L_{down} = ft
V_u = veh/h	Freeway Volume, V_F: 1772	V_D = veh/h
	Ramp Volume, V_R: 1413	
	Freeway Free-Flow Speed, S_{FF}: 55.0	
	Ramp Free-Flow Speed, S_{FR}: 25.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	1772	0.90	Level	17	0	0.922	1.00	2136
Ramp	1413	0.90	Level	52	0	0.794	1.00	1978
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 1.000 using Equation (Exhibit 13-6)

V_{12} = 2136 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	4114	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	4114	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = 32.7 (pc/mi/ln)

LOS = D (Exhibit 13-2)

Speed Determination

M_S = 0.528 (Exibit 13-11)

S_R= 48.1 mph (Exhibit 13-11)

S_0= N/A mph (Exhibit 13-11)

S = 48.1 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-526 EB
Agency or Company	Atkins	Junction	3110-EB On from I-26 EB
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2018 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Number of Lanes, N: 2	☐ Yes ☐ On
☑ No ☐ Off	Acceleration Lane Length, L_A: 625	☑ No ☐ Off
L_{up} = ft	Deceleration Lane Length L_D:	L_{down} = ft
V_u = veh/h	Freeway Volume, V_F: 2239	V_D = veh/h
	Ramp Volume, V_R: 1155	
	Freeway Free-Flow Speed, S_{FF}: 55.0	
	Ramp Free-Flow Speed, S_{FR}: 25.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	2239	0.90	Level	15	0	0.930	1.00	2674
Ramp	1155	0.90	Level	55	0	0.784	1.00	1636
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 1.000 using Equation (Exhibit 13-6)

V_{12} = 2674 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	4310	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	4310	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = 34.4 (pc/mi/ln)

LOS = D (Exhibit 13-2)

Speed Determination

M_S = 0.580 (Exibit 13-11)

S_R= 47.5 mph (Exhibit 13-11)

S_0= N/A mph (Exhibit 13-11)

S = 47.5 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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Navy Base ICTF

FREEWAY WEAVING WORKSHEET

General Information

Analyst	AJR
Agency/Company	Atkins
Date Performed	7/25/2014
Analysis Time Period	AM Peak

Site Information

Freeway/Dir of Travel	I-526 EB
Weaving Segment Location	3120 - I-26 WB to Rivers Ave
Analysis Year	2018 No Action

Project Description *Navy Base ICTF*

Inputs

Weaving configuration	One-Sided	Segment type	Freeway
Weaving number of lanes, N	3	Freeway minimum speed, S_{MIN}	15
Weaving segment length, L_S	1615ft	Freeway maximum capacity, C_{IFL}	2250
Freeway free-flow speed, FFS	55 mph	Terrain type	Level

Conversions to pc/h Under Base Conditions

	V (veh/h)	PHF	Truck (%)	RV (%)	E_T	E_R	f_{HV}	f_p	v (pc/h)
V_{FF}	2987	0.90	17	0	1.5	1.2	0.922	1.00	3601
V_{RF}	476	0.90	17	0	1.5	1.2	0.922	1.00	574
V_{FR}	198	0.90	19	0	1.5	1.2	0.913	1.00	241
V_{RR}	32	0.90	19	0	1.5	1.2	0.913	1.00	39
V_{NW}	3640							V =	4455
V_W	815								
VR	0.183								

Configuration Characteristics

Minimum maneuver lanes, N_{WL}	2 lc	Minimum weaving lane changes, LC_{MIN}	815 lc/h
Interchange density, ID	1.2 int/mi	Weaving lane changes, LC_W	1054 lc/h
Minimum RF lane changes, LC_{RF}	1 lc/pc	Non-weaving lane changes, LC_{NW}	1047 lc/h
Minimum FR lane changes, LC_{FR}	1 lc/pc	Total lane changes, LC_{ALL}	2101 lc/h
Minimum RR lane changes, LC_{RR}	lc/pc	Non-weaving vehicle index, I_{NW}	705

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment flow rate, v	4455 pc/h	Weaving intensity factor, W	0.278
Weaving segment capacity, c_w	5641 veh/h	Weaving segment speed, S	42.7 mph
Weaving segment v/c ratio	0.728	Average weaving speed, S_W	46.3 mph
Weaving segment density, D	34.8 pc/mi/ln	Average non-weaving speed, S_{NW}	42.0 mph
Level of Service, LOS	D	Maximum weaving length, L_{MAX}	4363 ft

Notes

a. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments".
b. For volumes that exceed the weaving segment capacity, the level of service is "F".

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Navy Base ICTF

FREEWAY WEAVING WORKSHEET

General Information

Analyst	AJR
Agency/Company	Atkins
Date Performed	7/25/2014
Analysis Time Period	PM Peak

Site Information

Freeway/Dir of Travel	I-526 EB
Weaving Segment Location	3120 - I-26 WB to Rivers Ave
Analysis Year	2018 No Action

Project Description *Navy Base ICTF*

Inputs

Weaving configuration	One-Sided	Segment type	Freeway
Weaving number of lanes, N	3	Freeway minimum speed, S_{MIN}	15
Weaving segment length, L_S	1615ft	Freeway maximum capacity, C_{IFL}	2250
Freeway free-flow speed, FFS	55 mph	Terrain type	Level

Conversions to pc/h Under Base Conditions

	V (veh/h)	PHF	Truck (%)	RV (%)	E_T	E_R	f_{HV}	f_p	v (pc/h)
V_{FF}	3092	0.90	15	0	1.5	1.2	0.930	1.00	3693
V_{RF}	416	0.90	15	0	1.5	1.2	0.930	1.00	497
V_{FR}	302	0.90	15	0	1.5	1.2	0.930	1.00	361
V_{RR}	41	0.90	11	0	1.5	1.2	0.948	1.00	48
V_{NW}	3741							V =	4599
V_W	858								
VR	0.187								

Configuration Characteristics

Minimum maneuver lanes, N_{WL}	2 lc	Minimum weaving lane changes, LC_{MIN}	858 lc/h
Interchange density, ID	1.2 int/mi	Weaving lane changes, LC_W	1097 lc/h
Minimum RF lane changes, LC_{RF}	1 lc/pc	Non-weaving lane changes, LC_{NW}	1068 lc/h
Minimum FR lane changes, LC_{FR}	1 lc/pc	Total lane changes, LC_{ALL}	2165 lc/h
Minimum RR lane changes, LC_{RR}	lc/pc	Non-weaving vehicle index, I_{NW}	725

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment flow rate, v	4599 pc/h	Weaving intensity factor, W	0.285
Weaving segment capacity, c_w	5685 veh/h	Weaving segment speed, S	42.3 mph
Weaving segment v/c ratio	0.753	Average weaving speed, S_W	46.1 mph
Weaving segment density, D	36.3 pc/mi/ln	Average non-weaving speed, S_{NW}	41.5 mph
Level of Service, LOS	E	Maximum weaving length, L_{MAX}	4399 ft

Notes

a. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments".
b. For volumes that exceed the weaving segment capacity, the level of service is "F".

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-526 EB
Agency or Company	Atkins	Junction	3130-EB Off to Rivers NB
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2018 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Freeway Number of Lanes, N	2	Downstream Adj Ramp	
☐ Yes	☐ On	Ramp Number of Lanes, N	1	☐ Yes	☐ On
☑ No	☐ Off	Acceleration Lane Length, L_A		☑ No	☐ Off
L_{up} =	ft	Deceleration Lane Length L_D	800	L_{down} =	ft
V_u =	veh/h	Freeway Volume, V_F	3463	V_D =	veh/h
		Ramp Volume, V_R	161		
		Freeway Free-Flow Speed, S_{FF}	55.0		
		Ramp Free-Flow Speed, S_{FR}	25.0		

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	3463	0.90	Level	17	0	0.922	1.00	4175
Ramp	161	0.90	Level	19	0	0.913	1.00	196
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 1.000 using Equation (Exhibit 13-7)

V_{12} = 4175 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	4175	Exhibit 13-8	4500	No
$V_{FO} = V_F - V_R$	3979	Exhibit 13-8	4500	No
V_R	196	Exhibit 13-10	1900	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	4175	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = 33.0 (pc/mi/ln)

LOS = D (Exhibit 13-2)

Speed Determination

D_s = 0.576 (Exhibit 13-12)

S_R= 47.5 mph (Exhibit 13-12)

S_0= N/A mph (Exhibit 13-12)

S = 47.5 mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-526 EB
Agency or Company	Atkins	Junction	3130-EB Off to Rivers NB
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2018 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Freeway Number of Lanes, N: 2	☐ Yes ☐ On
☑ No ☐ Off	Ramp Number of Lanes, N: 1	☑ No ☐ Off
L_{up} = ft	Acceleration Lane Length, L_A	L_{down} = ft
V_u = veh/h	Deceleration Lane Length L_D: 800	V_D = veh/h
	Freeway Volume, V_F: 3508	
	Ramp Volume, V_R: 332	
	Freeway Free-Flow Speed, S_{FF}: 55.0	
	Ramp Free-Flow Speed, S_{FR}: 25.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	3508	0.90	Level	15	0	0.930	1.00	4190
Ramp	332	0.90	Level	11	0	0.948	1.00	389
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 1.000 using Equation (Exhibit 13-7)

V_{12} = 4190 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	4190	Exhibit 13-8	4500	No
$V_{FO} = V_F - V_R$	3801	Exhibit 13-8	4500	No
V_R	389	Exhibit 13-10	1900	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	4190	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = 33.1 (pc/mi/ln)

LOS = D (Exhibit 13-2)

Speed Determination

D_s = 0.593 (Exhibit 13-12)

S_R= 47.3 mph (Exhibit 13-12)

S_0= N/A mph (Exhibit 13-12)

S = 47.3 mph (Exhibit 13-13)

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-526 EB*
Agency or Company	*Atkins*	From/To	*3135-RiversNB Off to Rivers On*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2018 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*3302*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*17*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.922*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*55.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*55.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1990*	pc/h/ln
S	*54.1*	mph
D = v_p / S	*36.8*	pc/mi/ln
LOS	*E*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-526 EB*
Agency or Company	*Atkins*	From/To	*3135-RiversNB Off to Rivers On*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*PM Peak*	Analysis Year	*2018 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*3176*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*15*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.930*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*55.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*55.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1897*	pc/h/ln
S	*54.8*	mph
D = v_p / S	*34.6*	pc/mi/ln
LOS	*D*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-526 EB
Agency or Company	Atkins	Junction	3140-EB On from Rivers
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2018 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Freeway Number of Lanes, N: 2	☐ Yes ☐ On
☑ No ☐ Off	Ramp Number of Lanes, N: 1	☑ No ☐ Off
L_{up} = ft	Acceleration Lane Length, L_A: 825	L_{down} = ft
V_u = veh/h	Deceleration Lane Length L_D:	V_D = veh/h
	Freeway Volume, V_F: 3302	
	Ramp Volume, V_R: 483	
	Freeway Free-Flow Speed, S_{FF}: 55.0	
	Ramp Free-Flow Speed, S_{FR}: 45.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	3302	0.90	Level	17	0	0.922	1.00	3981
Ramp	483	0.90	Level	4	0	0.980	1.00	547
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 1.000 using Equation (Exhibit 13-6)

V_{12} = 3981 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	4528	Exhibit 13-8		Yes

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	4528	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = 35.4 (pc/mi/ln)

LOS = F (Exhibit 13-2)

Speed Determination

M_S = 0.608 (Exibit 13-11)

S_R= 47.1 mph (Exhibit 13-11)

S_0= N/A mph (Exhibit 13-11)

S = 47.1 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-526 EB
Agency or Company	Atkins	Junction	3140-EB On from Rivers
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2018 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Freeway Number of Lanes, N: 2	☐ Yes ☐ On
☑ No ☐ Off	Ramp Number of Lanes, N: 1	☑ No ☐ Off
L_{up} = ft	Acceleration Lane Length, L_A: 825	L_{down} = ft
V_u = veh/h	Deceleration Lane Length L_D:	V_D = veh/h
	Freeway Volume, V_F: 3176	
	Ramp Volume, V_R: 446	
	Freeway Free-Flow Speed, S_{FF}: 55.0	
	Ramp Free-Flow Speed, S_{FR}: 45.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	3176	0.90	Level	15	0	0.930	1.00	3794
Ramp	446	0.90	Level	3	0	0.985	1.00	503
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 1.000 using Equation (Exhibit 13-6)

V_{12} = 3794 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	4297	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	4297	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = 33.6 (pc/mi/ln)

LOS = D (Exhibit 13-2)

Speed Determination

M_S = 0.533 (Exibit 13-11)

S_R= 48.1 mph (Exhibit 13-11)

S_0= N/A mph (Exhibit 13-11)

S = 48.1 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-526 EB*
Agency or Company	*Atkins*	From/To	*3150-Rivers to Rhett*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2018 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*3785*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*16*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.926*

Speed Inputs			Calc Speed Adj and FFS		
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f_{LW}		mph
Number of Lanes, N	*2*		f_{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	*60.0*	mph	FFS	*60.0*	mph
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures			Design (N)	
Operational (LOS)			Design (N)	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*2271*	pc/h/ln	Design LOS	
			v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h/ln
S	*51.8*	mph	S	mph
D = v_p / S	*43.8*	pc/mi/ln	D = v_p / S	pc/mi/ln
LOS	*E*		Required Number of Lanes, N	

Glossary		Factor Location	
N - Number of lanes	S - Speed	E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
V - Hourly volume	D - Density	E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 11-18	TRD - Page 11-11
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 11-2, 11-3	
DDHV - Directional design hour volume			

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-526 EB*
Agency or Company	*Atkins*	From/To	*3150-Rivers to Rhett*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*PM Peak*	Analysis Year	*2018 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*3622*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*15*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.930*

Speed Inputs			Calc Speed Adj and FFS		
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f_{LW}		mph
Number of Lanes, N	*2*		f_{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	*60.0*	mph	FFS	*60.0*	mph
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures			Design (N)	
Operational (LOS)			Design (N)	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*2163*	pc/h/ln	Design LOS	
			v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h/ln
S	*54.2*	mph	S	mph
D = v_p / S	*39.9*	pc/mi/ln	D = v_p / S	pc/mi/ln
LOS	*E*		Required Number of Lanes, N	

Glossary		Factor Location	
N - Number of lanes	S - Speed	E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
V - Hourly volume	D - Density	E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 11-18	TRD - Page 11-11
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 11-2, 11-3	
DDHV - Directional design hour volume			

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F-2843

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-526 EB
Agency or Company	Atkins	Junction	3160-EB Off to Rhett
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2018 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Number of Lanes, N	2	Downstream Adj Ramp	
☐ Yes	☐ On	Acceleration Lane Length, L_A		☐ Yes	☐ On
☑ No	☐ Off	Deceleration Lane Length L_D	225	☑ No	☐ Off
L_{up} =	ft	Freeway Volume, V_F	3785	L_{down} =	ft
V_u =	veh/h	Ramp Volume, V_R	469	V_D =	veh/h
		Freeway Free-Flow Speed, S_{FF}	60.0		
		Ramp Free-Flow Speed, S_{FR}	45.0		

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	3785	0.90	Level	16	0	0.926	1.00	4542
Ramp	469	0.90	Level	7	0	0.966	1.00	539
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 1.000 using Equation (Exhibit 13-7)

V_{12} = 4542 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	4542	Exhibit 13-8	4600	No
$V_{FO} = V_F - V_R$	4003	Exhibit 13-8	4600	No
V_R	539	Exhibit 13-10	2100	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	4542	Exhibit 13-8	4400:All	Yes

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = 41.3 (pc/mi/ln)

LOS = E (Exhibit 13-2)

Speed Determination

D_s = 0.347 (Exhibit 13-12)

S_R= 53.8 mph (Exhibit 13-12)

S_0= N/A mph (Exhibit 13-12)

S = 53.8 mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-526 EB
Agency or Company	Atkins	Junction	3160-EB Off to Rhett
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2018 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Number of Lanes, N	2	Downstream Adj Ramp	
☐ Yes	☐ On	Acceleration Lane Length, L_A		☐ Yes	☐ On
☑ No	☐ Off	Deceleration Lane Length L_D	225	☑ No	☐ Off
L_{up} =	ft	Freeway Volume, V_F	3622	L_{down} =	ft
		Ramp Volume, V_R	688		
V_u =	veh/h	Freeway Free-Flow Speed, S_{FF}	60.0	V_D =	veh/h
		Ramp Free-Flow Speed, S_{FR}	45.0		

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	3622	0.90	Level	15	0	0.930	1.00	4326
Ramp	688	0.90	Level	4	0	0.980	1.00	780
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 1.000 using Equation (Exhibit 13-7)

V_{12} = 4326 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	4326	Exhibit 13-8	4600	No
$V_{FO} = V_F - V_R$	3546	Exhibit 13-8	4600	No
V_R	780	Exhibit 13-10	2100	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	4326	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = 39.4 (pc/mi/ln)

LOS = E (Exhibit 13-2)

Speed Determination

D_s = 0.368 (Exhibit 13-12)

S_R= 53.4 mph (Exhibit 13-12)

S_0= N/A mph (Exhibit 13-12)

S = 53.4 mph (Exhibit 13-13)

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-526 EB*
Agency or Company	*Atkins*	From/To	*3165 - Rhett Off to Rhett On*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2018 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*3316*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*16*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.926*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*60.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*60.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1990*	pc/h/ln
S	*57.2*	mph
D = v_p / S	*34.8*	pc/mi/ln
LOS	*D*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-526 EB*
Agency or Company	*Atkins*	From/To	*3165 - Rhett Off to Rhett On*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*PM Peak*	Analysis Year	*2018 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*2934*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*15*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.930*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*60.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*60.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1752*	pc/h/ln
S	*59.6*	mph
D = v_p / S	*29.4*	pc/mi/ln
LOS	*D*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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F-2847

Navy Base ICTF

FREEWAY WEAVING WORKSHEET

General Information

Analyst	AJR
Agency/Company	Atkins
Date Performed	7/25/2014
Analysis Time Period	AM Peak

Site Information

Freeway/Dir of Travel	I-526 EB
Weaving Segment Location	3170 - Rhett to Virginia
Analysis Year	2018 No Action

Project Description *Navy Base ICTF*

Inputs

Weaving configuration	One-Sided	Segment type	Freeway
Weaving number of lanes, N	3	Freeway minimum speed, S_{MIN}	15
Weaving segment length, L_S	1090ft	Freeway maximum capacity, C_{IFL}	2300
Freeway free-flow speed, FFS	60 mph	Terrain type	Level

Conversions to pc/h Under Base Conditions

	V (veh/h)	PHF	Truck (%)	RV (%)	E_T	E_R	f_{HV}	f_p	v (pc/h)
V_{FF}	2833	0.90	15	0	1.5	1.2	0.930	1.00	3384
V_{RF}	1120	0.90	15	0	1.5	1.2	0.930	1.00	1338
V_{FR}	483	0.90	15	0	1.5	1.2	0.930	1.00	577
V_{RR}	191	0.90	13	0	1.5	1.2	0.939	1.00	226
V_{NW}	3610							V =	5525
V_W	1915								
VR	0.347								

Configuration Characteristics

Minimum maneuver lanes, N_{WL}	2 lc	Minimum weaving lane changes, LC_{MIN}	1915 lc/h
Interchange density, ID	0.7 int/mi	Weaving lane changes, LC_W	2066 lc/h
Minimum RF lane changes, LC_{RF}	1 lc/pc	Non-weaving lane changes, LC_{NW}	757 lc/h
Minimum FR lane changes, LC_{FR}	1 lc/pc	Total lane changes, LC_{ALL}	2823 lc/h
Minimum RR lane changes, LC_{RR}	lc/pc	Non-weaving vehicle index, I_{NW}	275

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment flow rate, v	5525 pc/h	Weaving intensity factor, W	0.479
Weaving segment capacity, c_w	5353 veh/h	Weaving segment speed, S	39.8 mph
Weaving segment v/c ratio	0.960	Average weaving speed, S_W	45.4 mph
Weaving segment density, D	46.2 pc/mi/ln	Average non-weaving speed, S_{NW}	37.4 mph
Level of Service, LOS	E	Maximum weaving length, L_{MAX}	6089 ft

Notes

a. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments".
b. For volumes that exceed the weaving segment capacity, the level of service is "F".

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Navy Base ICTF

FREEWAY WEAVING WORKSHEET

General Information

Analyst	AJR
Agency/Company	Atkins
Date Performed	7/25/2014
Analysis Time Period	PM Peak

Site Information

Freeway/Dir of Travel	I-526 EB
Weaving Segment Location	3170 - Rhett to Virginia
Analysis Year	2018 No Action

Project Description *Navy Base ICTF*

Inputs

Weaving configuration	One-Sided	Segment type	Freeway
Weaving number of lanes, N	3	Freeway minimum speed, S_{MIN}	15
Weaving segment length, L_S	1090ft	Freeway maximum capacity, C_{IFL}	2300
Freeway free-flow speed, FFS	60 mph	Terrain type	Level

Conversions to pc/h Under Base Conditions

	V (veh/h)	PHF	Truck (%)	RV (%)	E_T	E_R	f_{HV}	f_p	v (pc/h)
V_{FF}	2799	0.90	14	0	1.5	1.2	0.935	1.00	3328
V_{RF}	961	0.90	14	0	1.5	1.2	0.935	1.00	1143
V_{FR}	135	0.90	42	0	1.5	1.2	0.826	1.00	182
V_{RR}	46	0.90	42	0	1.5	1.2	0.826	1.00	62
V_{NW}	3390							V =	4715
V_W	1325								
VR	0.281								

Configuration Characteristics

Minimum maneuver lanes, N_{WL}	2 lc	Minimum weaving lane changes, LC_{MIN}	1325 lc/h
Interchange density, ID	0.7 int/mi	Weaving lane changes, LC_W	1476 lc/h
Minimum RF lane changes, LC_{RF}	1 lc/pc	Non-weaving lane changes, LC_{NW}	711 lc/h
Minimum FR lane changes, LC_{FR}	1 lc/pc	Total lane changes, LC_{ALL}	2187 lc/h
Minimum RR lane changes, LC_{RR}	lc/pc	Non-weaving vehicle index, I_{NW}	259

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment flow rate, v	4715 pc/h	Weaving intensity factor, W	0.391
Weaving segment capacity, c_w	5529 veh/h	Weaving segment speed, S	44.1 mph
Weaving segment v/c ratio	0.797	Average weaving speed, S_W	47.3 mph
Weaving segment density, D	35.7 pc/mi/ln	Average non-weaving speed, S_{NW}	42.9 mph
Level of Service, LOS	E	Maximum weaving length, L_{MAX}	5381 ft

Notes

a. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments".
b. For volumes that exceed the weaving segment capacity, the level of service is "F".

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-526 EB*
Agency or Company	*Atkins*	From/To	*3180-Virginia to ClementsFerry*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2018 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*3953*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*12*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.943*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*60.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*60.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*2328*	pc/h/ln
S	*50.4*	mph
D = v_p / S	*46.2*	pc/mi/ln
LOS	*F*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-526 EB*
Agency or Company	*Atkins*	From/To	*3180-Virginia to ClementsFerry*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*PM Peak*	Analysis Year	*2018 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*3760*	veh/h	Peak-Hour Factor, PHF	*0.90*	
AADT		veh/day	%Trucks and Buses, P_T	*12*	
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*	
Peak-Hr Direction Prop, D			General Terrain:	*Level*	
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*	

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.943*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*60.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*60.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*2214*	pc/h/ln
S	*53.2*	mph
D = v_p / S	*41.7*	pc/mi/ln
LOS	*E*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-526 EB
Agency or Company	Atkins	Junction	3190-EB Off to ClementsFerrySB
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2018 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Number of Lanes, N	2	Downstream Adj Ramp	
☐ Yes	☐ On	Acceleration Lane Length, L_A		☐ Yes	☐ On
☑ No	☐ Off	Deceleration Lane Length L_D	250	☑ No	☐ Off
L_{up} =	ft	Freeway Volume, V_F	3953	L_{down} =	ft
		Ramp Volume, V_R	331		
V_u =	veh/h	Freeway Free-Flow Speed, S_{FF}	60.0	V_D =	veh/h
		Ramp Free-Flow Speed, S_{FR}	45.0		

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	3953	0.90	Level	12	0	0.943	1.00	4656
Ramp	331	0.90	Level	8	0	0.962	1.00	382
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 1.000 using Equation (Exhibit 13-7)

V_{12} = 4656 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	4656	Exhibit 13-8	4600	Yes
$V_{FO} = V_F - V_R$	4274	Exhibit 13-8	4600	No
V_R	382	Exhibit 13-10	2100	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	4656	Exhibit 13-8	4400:All	Yes

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = 42.0 (pc/mi/ln)

LOS = F (Exhibit 13-2)

Speed Determination

D_s = 0.332 (Exhibit 13-12)

S_R= 54.0 mph (Exhibit 13-12)

S_0= N/A mph (Exhibit 13-12)

S = 54.0 mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-526 EB
Agency or Company	Atkins	Junction	3190-EB Off to ClementsFerrySB
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2018 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Number of Lanes, N	2	Downstream Adj Ramp	
☐ Yes	☐ On	Acceleration Lane Length, L_A		☐ Yes	☐ On
☑ No	☐ Off	Deceleration Lane Length L_D	250	☑ No	☐ Off
L_{up} =	ft	Freeway Volume, V_F	3760	L_{down} =	ft
		Ramp Volume, V_R	172		
V_u =	veh/h	Freeway Free-Flow Speed, S_{FF}	60.0	V_D =	veh/h
		Ramp Free-Flow Speed, S_{FR}	45.0		

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	3760	0.90	Level	12	0	0.943	1.00	4428
Ramp	172	0.90	Level	13	0	0.939	1.00	204
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 1.000 using Equation (Exhibit 13-7)

V_{12} = 4428 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	4428	Exhibit 13-8	4600	No
$V_{FO} = V_F - V_R$	4224	Exhibit 13-8	4600	No
V_R	204	Exhibit 13-10	2100	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	4428	Exhibit 13-8	4400:All	Yes

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = 40.1 (pc/mi/ln)

LOS = E (Exhibit 13-2)

Speed Determination

D_s = 0.316 (Exhibit 13-12)

S_R= 54.3 mph (Exhibit 13-12)

S_0= N/A mph (Exhibit 13-12)

S = 54.3 mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-526 EB
Agency or Company	Atkins	Junction	3200-EB Off to ClementsFerryNB
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2018 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Freeway Number of Lanes, N	2	Downstream Adj Ramp	
☐ Yes	☐ On	Ramp Number of Lanes, N	1	☐ Yes	☐ On
☑ No	☐ Off	Acceleration Lane Length, L_A		☑ No	☐ Off
L_{up} =	ft	Deceleration Lane Length L_D	900	L_{down} =	ft
V_u =	veh/h	Freeway Volume, V_F	3622	V_D =	veh/h
		Ramp Volume, V_R	890		
		Freeway Free-Flow Speed, S_{FF}	60.0		
		Ramp Free-Flow Speed, S_{FR}	25.0		

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	3622	0.90	Level	12	0	0.943	1.00	4266
Ramp	890	0.90	Level	21	0	0.905	1.00	1093
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 1.000 using Equation (Exhibit 13-7)

V_{12} = 4266 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	4266	Exhibit 13-8	4600	No
$V_{FO} = V_F - V_R$	3173	Exhibit 13-8	4600	No
V_R	1093	Exhibit 13-10	1900	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	4266	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = 32.8 (pc/mi/ln)

LOS = D (Exhibit 13-2)

Speed Determination

D_s = 0.656 (Exhibit 13-12)

S_R= 48.2 mph (Exhibit 13-12)

S_0= N/A mph (Exhibit 13-12)

S = 48.2 mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-526 EB
Agency or Company	Atkins	Junction	3200-EB Off to ClementsFerryNB
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2018 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Freeway Number of Lanes, N	2	Downstream Adj Ramp	
☐ Yes	☐ On	Ramp Number of Lanes, N	1	☐ Yes	☐ On
☑ No	☐ Off	Acceleration Lane Length, L_A		☑ No	☐ Off
L_{up} =	ft	Deceleration Lane Length L_D	900	L_{down} =	ft
V_u =	veh/h	Freeway Volume, V_F	3588	V_D =	veh/h
		Ramp Volume, V_R	817		
		Freeway Free-Flow Speed, S_{FF}	60.0		
		Ramp Free-Flow Speed, S_{FR}	25.0		

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	3588	0.90	Level	12	0	0.943	1.00	4226
Ramp	817	0.90	Level	20	0	0.909	1.00	999
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 1.000 using Equation (Exhibit 13-7)

V_{12} = 4226 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	4226	Exhibit 13-8	4600	No
$V_{FO} = V_F - V_R$	3227	Exhibit 13-8	4600	No
V_R	999	Exhibit 13-10	1900	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	4226	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = 32.5 (pc/mi/ln)

LOS = D (Exhibit 13-2)

Speed Determination

D_s = 0.648 (Exhibit 13-12)

S_R= 48.3 mph (Exhibit 13-12)

S_0= N/A mph (Exhibit 13-12)

S = 48.3 mph (Exhibit 13-13)

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-526 EB*
Agency or Company	*Atkins*	From/To	*3205-ClemFerry NB Off to NB On*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2018 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*2732*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*12*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.943*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*60.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*60.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1609*	pc/h/ln
S	*60.0*	mph
D = v_p / S	*26.8*	pc/mi/ln
LOS	*D*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-526 EB*
Agency or Company	*Atkins*	From/To	*3205-ClemFerry NB Off to NB On*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*PM Peak*	Analysis Year	*2018 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*2771*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*12*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.943*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*60.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*60.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1632*	pc/h/ln
S	*60.0*	mph
D = v_p / S	*27.2*	pc/mi/ln
LOS	*D*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-526 EB
Agency or Company	Atkins	Junction	3210-EB On from Clements Ferry
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2018 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Freeway Number of Lanes, N: 2	☐ Yes ☐ On
☑ No ☐ Off	Ramp Number of Lanes, N: 1	☑ No ☐ Off
L_{up} = ft	Acceleration Lane Length, L_A: 1025	L_{down} = ft
V_u = veh/h	Deceleration Lane Length L_D:	V_D = veh/h
	Freeway Volume, V_F: 2732	
	Ramp Volume, V_R: 380	
	Freeway Free-Flow Speed, S_{FF}: 60.0	
	Ramp Free-Flow Speed, S_{FR}: 45.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	2732	0.90	Level	12	0	0.943	1.00	3218
Ramp	380	0.90	Level	9	0	0.957	1.00	441
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 1.000 using Equation (Exhibit 13-6)

V_{12} = 3218 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	3659	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	3659	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = 27.4 (pc/mi/ln)

LOS = C (Exhibit 13-2)

Speed Determination

M_S = 0.380 (Exibit 13-11)

S_R= 53.2 mph (Exhibit 13-11)

S_0= N/A mph (Exhibit 13-11)

S = 53.2 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-526 EB
Agency or Company	Atkins	Junction	3210-EB On from Clements Ferry
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2018 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Freeway Number of Lanes, N: 2	☐ Yes ☐ On
☑ No ☐ Off	Ramp Number of Lanes, N: 1	☑ No ☐ Off
L_{up} = ft	Acceleration Lane Length, L_A: 1025	L_{down} = ft
V_u = veh/h	Deceleration Lane Length L_D:	V_D = veh/h
	Freeway Volume, V_F: 2771	
	Ramp Volume, V_R: 582	
	Freeway Free-Flow Speed, S_{FF}: 60.0	
	Ramp Free-Flow Speed, S_{FR}: 45.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	2771	0.90	Level	12	0	0.943	1.00	3264
Ramp	582	0.90	Level	5	0	0.976	1.00	663
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 1.000 using Equation (Exhibit 13-6)

V_{12} = 3264 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	3927	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	3927	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = 29.4 (pc/mi/ln)

LOS = D (Exhibit 13-2)

Speed Determination

M_S = 0.427 (Exibit 13-11)

S_R= 52.3 mph (Exhibit 13-11)

S_0= N/A mph (Exhibit 13-11)

S = 52.3 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-526 EB*
Agency or Company	*Atkins*	From/To	*3220-ClementsFerrytoRiversLand*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2018 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*3112*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*10*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.952*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*60.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*60.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1815*	pc/h/ln
S	*59.2*	mph
D = v_p / S	*30.7*	pc/mi/ln
LOS	*D*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-526 EB*
Agency or Company	*Atkins*	From/To	*3220-ClementsFerrytoRiversLand*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*PM Peak*	Analysis Year	*2018 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*3353*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*9*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.957*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*60.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*60.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1947*	pc/h/ln
S	*57.8*	mph
D = v_p / S	*33.7*	pc/mi/ln
LOS	*D*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-526 EB
Agency or Company	Atkins	Junction	3230-EB Off to River Landing
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2018 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Freeway Number of Lanes, N: 2	☐ Yes ☐ On
☑ No ☐ Off	Ramp Number of Lanes, N: 1	☑ No ☐ Off
L_{up} = ft	Acceleration Lane Length, L_A	L_{down} = ft
V_u = veh/h	Deceleration Lane Length L_D: 800	V_D = veh/h
	Freeway Volume, V_F: 3112	
	Ramp Volume, V_R: 774	
	Freeway Free-Flow Speed, S_{FF}: 65.0	
	Ramp Free-Flow Speed, S_{FR}: 45.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	3112	0.90	Level	10	0	0.952	1.00	3631
Ramp	774	0.90	Level	3	0	0.985	1.00	873
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 1.000 using Equation (Exhibit 13-7)

V_{12} = 3631 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	3631	Exhibit 13-8	4700	No
$V_{FO} = V_F - V_R$	2758	Exhibit 13-8	4700	No
V_R	873	Exhibit 13-10	2100	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	3631	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = 28.3 (pc/mi/ln)

LOS = D (Exhibit 13-2)

Speed Determination

D_s = 0.377 (Exhibit 13-12)

S_R= 56.3 mph (Exhibit 13-12)

S_0= N/A mph (Exhibit 13-12)

S = 56.3 mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-526 EB
Agency or Company	Atkins	Junction	3230-EB Off to River Landing
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2018 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Freeway Number of Lanes, N: 2	☐ Yes ☐ On
☑ No ☐ Off	Ramp Number of Lanes, N: 1	☑ No ☐ Off
L_{up} = ft	Acceleration Lane Length, L_A	L_{down} = ft
V_u = veh/h	Deceleration Lane Length L_D: 800	V_D = veh/h
	Freeway Volume, V_F: 3353	
	Ramp Volume, V_R: 801	
	Freeway Free-Flow Speed, S_{FF}: 65.0	
	Ramp Free-Flow Speed, S_{FR}: 45.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	3353	0.90	Level	9	0	0.957	1.00	3893
Ramp	801	0.90	Level	2	0	0.990	1.00	899
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 1.000 using Equation (Exhibit 13-7)

V_{12} = 3893 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	3893	Exhibit 13-8	4700	No
$V_{FO} = V_F - V_R$	2994	Exhibit 13-8	4700	No
V_R	899	Exhibit 13-10	2100	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	3893	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = 30.5 (pc/mi/ln)

LOS = D (Exhibit 13-2)

Speed Determination

D_s = 0.379 (Exhibit 13-12)

S_R= 56.3 mph (Exhibit 13-12)

S_0= N/A mph (Exhibit 13-12)

S = 56.3 mph (Exhibit 13-13)

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-526 EB*
Agency or Company	*Atkins*	From/To	*3235-RiverLa Off to RiverLa On*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2018 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*2338*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*12*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.943*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*65.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*65.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1377*	pc/h/ln
S	*65.0*	mph
D = v_p / S	*21.2*	pc/mi/ln
LOS	*C*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-526 EB*
Agency or Company	*Atkins*	From/To	*3235-RiverLa Off to RiverLa On*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*PM Peak*	Analysis Year	*2018 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*2552*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*11*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.948*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*65.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*65.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1496*	pc/h/ln
S	*64.9*	mph
D = v_p / S	*23.1*	pc/mi/ln
LOS	*C*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-526 EB
Agency or Company	Atkins	Junction	3240-EB On from River Landing
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2018 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Number of Lanes, N: 2	☐ Yes ☐ On
☑ No ☐ Off	Acceleration Lane Length, L_A: 1400	☑ No ☐ Off
L_{up} = ft	Deceleration Lane Length L_D:	L_{down} = ft
V_u = veh/h	Freeway Volume, V_F: 2338	V_D = veh/h
	Ramp Volume, V_R: 620	
	Freeway Free-Flow Speed, S_{FF}: 65.0	
	Ramp Free-Flow Speed, S_{FR}: 25.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	2338	0.90	Level	12	0	0.943	1.00	2754
Ramp	620	0.90	Level	10	0	0.952	1.00	723
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 1.000 using Equation (Exhibit 13-6)

V_{12} = 2754 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	3477	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	3477	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = 23.5 (pc/mi/ln)

LOS = C (Exhibit 13-2)

Speed Determination

M_S = 0.377 (Exibit 13-11)

S_R= 56.3 mph (Exhibit 13-11)

S_0= N/A mph (Exhibit 13-11)

S = 56.3 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-526 EB
Agency or Company	Atkins	Junction	3240-EB On from River Landing
Date Performed	4/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2018 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Number of Lanes, N: 2	☐ Yes ☐ On
☑ No ☐ Off	Acceleration Lane Length, L_A: 1400	☑ No ☐ Off
L_{up} = ft	Deceleration Lane Length L_D:	L_{down} = ft
V_u = veh/h	Freeway Volume, V_F: 2552	V_D = veh/h
	Ramp Volume, V_R: 510	
	Freeway Free-Flow Speed, S_{FF}: 65.0	
	Ramp Free-Flow Speed, S_{FR}: 25.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	2552	0.90	Level	11	0	0.948	1.00	2992
Ramp	510	0.90	Level	10	0	0.952	1.00	595
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 1.000 using Equation (Exhibit 13-6)

V_{12} = 2992 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	3587	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	3587	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = 24.4 (pc/mi/ln)

LOS = C (Exhibit 13-2)

Speed Determination

M_S = 0.392 (Exibit 13-11)

S_R= 56.0 mph (Exhibit 13-11)

S_0= N/A mph (Exhibit 13-11)

S = 56.0 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-526 EB*
Agency or Company	*Atkins*	From/To	*3250-RiverLanding to LongPoint*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2018 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*2958*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*12*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.943*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*65.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*65.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1742*	pc/h/ln
S	*63.3*	mph
D = v_p / S	*27.5*	pc/mi/ln
LOS	*D*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-526 EB*
Agency or Company	*Atkins*	From/To	*3250-RiverLanding to LongPoint*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*PM Peak*	Analysis Year	*2018 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*3062*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*11*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.948*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*65.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*65.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1795*	pc/h/ln
S	*62.8*	mph
D = v_p / S	*28.6*	pc/mi/ln
LOS	*D*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-526 EB
Agency or Company	Atkins	Junction	3260-EB Off to Long Point
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2018 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Freeway Number of Lanes, N	2	Downstream Adj Ramp	
☐ Yes	☐ On	Ramp Number of Lanes, N	1	☐ Yes	☐ On
☑ No	☐ Off	Acceleration Lane Length, L_A		☑ No	☐ Off
L_{up} =	ft	Deceleration Lane Length L_D	225	L_{down} =	ft
V_u =	veh/h	Freeway Volume, V_F	2958	V_D =	veh/h
		Ramp Volume, V_R	1081		
		Freeway Free-Flow Speed, S_{FF}	65.0		
		Ramp Free-Flow Speed, S_{FR}	45.0		

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	2958	0.90	Level	12	0	0.943	1.00	3484
Ramp	1081	0.90	Level	23	0	0.897	1.00	1339
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 1.000 using Equation (Exhibit 13-7)

V_{12} = 3484 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	3484	Exhibit 13-8	4700	No
$V_{FO} = V_F - V_R$	2145	Exhibit 13-8	4700	No
V_R	1339	Exhibit 13-10	2100	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	3484	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = 32.2 (pc/mi/ln)

LOS = D (Exhibit 13-2)

Speed Determination

D_s = 0.419 (Exhibit 13-12)

S_R= 55.4 mph (Exhibit 13-12)

S_0= N/A mph (Exhibit 13-12)

S = 55.4 mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-526 EB
Agency or Company	Atkins	Junction	3260-EB Off to Long Point
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2018 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp
☐ Yes ☐ On
☑ No ☐ Off
L_{up} = ft
V_u = veh/h

Freeway Number of Lanes, N	2
Ramp Number of Lanes, N	1
Acceleration Lane Length, L_A	
Deceleration Lane Length L_D	225
Freeway Volume, V_F	3062
Ramp Volume, V_R	1158
Freeway Free-Flow Speed, S_{FF}	65.0
Ramp Free-Flow Speed, S_{FR}	45.0

Downstream Adj Ramp
☐ Yes ☐ On
☑ No ☐ Off
L_{down} = ft
V_D = veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	3062	0.90	Level	11	0	0.948	1.00	3589
Ramp	1158	0.90	Level	19	0	0.913	1.00	1409
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)
P_{FM} = using Equation (Exhibit 13-6)
V_{12} = pc/h
V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)
Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No
Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No
If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = (pc/mi/ln)
LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)
S_R= mph (Exhibit 13-11)
S_0= mph (Exhibit 13-11)
S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)
P_{FD} = 1.000 using Equation (Exhibit 13-7)
V_{12} = 3589 pc/h
V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)
Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No
Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No
If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	3589	Exhibit 13-8	4700	No
$V_{FO} = V_F - V_R$	2180	Exhibit 13-8	4700	No
V_R	1409	Exhibit 13-10	2100	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	3589	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = 33.1 (pc/mi/ln)
LOS = D (Exhibit 13-2)

Speed Determination

D_s = 0.425 (Exhibit 13-12)
S_R= 55.2 mph (Exhibit 13-12)
S_0= N/A mph (Exhibit 13-12)
S = 55.2 mph (Exhibit 13-13)

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-526 EB*
Agency or Company	*Atkins*	From/To	*3265-LongPt Off to LongPtWB On*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2018 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*1877*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*12*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.943*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*65.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*65.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1105*	pc/h/ln
S	*65.0*	mph
D = v_p / S	*17.0*	pc/mi/ln
LOS	*B*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-526 EB*
Agency or Company	*Atkins*	From/To	*3265-LongPt Off to LongPtWB On*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*PM Peak*	Analysis Year	*2018 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*1904*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*11*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.948*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*65.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*65.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1116*	pc/h/ln
S	*65.0*	mph
D = v_p / S	*17.2*	pc/mi/ln
LOS	*B*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-526 EB
Agency or Company	Atkins	Junction	3270-EB On from Long Point WB
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2018 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On		☐ Yes ☐ On
☑ No ☐ Off		☑ No ☐ Off
L_{up} = ft		L_{down} = ft
V_u = veh/h		V_D = veh/h

Freeway Number of Lanes, N	2
Ramp Number of Lanes, N	1
Acceleration Lane Length, L_A	925
Deceleration Lane Length L_D	
Freeway Volume, V_F	1877
Ramp Volume, V_R	471
Freeway Free-Flow Speed, S_{FF}	65.0
Ramp Free-Flow Speed, S_{FR}	25.0

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	1877	0.90	Level	12	0	0.943	1.00	2211
Ramp	471	0.90	Level	6	0	0.971	1.00	539
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 1.000 using Equation (Exhibit 13-6)

V_{12} = 2211 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	2750	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	2750	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = 20.9 (pc/mi/ln)

LOS = C (Exhibit 13-2)

Speed Determination

M_S = 0.336 (Exibit 13-11)

S_R= 57.3 mph (Exhibit 13-11)

S_0= N/A mph (Exhibit 13-11)

S = 57.3 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-526 EB
Agency or Company	Atkins	Junction	3270-EB On from Long Point WB
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2018 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp

☐ Yes ☐ On

☑ No ☐ Off

L_{up} = ft

V_u = veh/h

Freeway Number of Lanes, N	2
Ramp Number of Lanes, N	1
Acceleration Lane Length, L_A	925
Deceleration Lane Length L_D	
Freeway Volume, V_F	1904
Ramp Volume, V_R	471
Freeway Free-Flow Speed, S_{FF}	65.0
Ramp Free-Flow Speed, S_{FR}	25.0

Downstream Adj Ramp

☐ Yes ☐ On

☑ No ☐ Off

L_{down} = ft

V_D = veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	1904	0.90	Level	11	0	0.948	1.00	2232
Ramp	471	0.90	Level	5	0	0.976	1.00	536
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 1.000 using Equation (Exhibit 13-6)

V_{12} = 2232 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	2768	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	2768	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = 21.0 (pc/mi/ln)

LOS = C (Exhibit 13-2)

Speed Determination

M_S = 0.337 (Exibit 13-11)

S_R= 57.3 mph (Exhibit 13-11)

S_0= N/A mph (Exhibit 13-11)

S = 57.3 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-526 EB
Agency or Company	Atkins	Junction	3280-EB On from Long Point EB
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2018 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Freeway Number of Lanes, N: 2	☐ Yes ☐ On
☑ No ☐ Off	Ramp Number of Lanes, N: 1	☑ No ☐ Off
L_{up} = ft	Acceleration Lane Length, L_A: 625	L_{down} = ft
V_u = veh/h	Deceleration Lane Length L_D:	V_D = veh/h
	Freeway Volume, V_F: 2348	
	Ramp Volume, V_R: 304	
	Freeway Free-Flow Speed, S_{FF}: 65.0	
	Ramp Free-Flow Speed, S_{FR}: 45.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	2348	0.90	Level	12	0	0.943	1.00	2765
Ramp	304	0.90	Level	13	0	0.939	1.00	360
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 1.000 using Equation (Exhibit 13-6)

V_{12} = 2765 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	3125	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	3125	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = 25.8 (pc/mi/ln)

LOS = C (Exhibit 13-2)

Speed Determination

M_S = 0.354 (Exibit 13-11)

S_R= 56.9 mph (Exhibit 13-11)

S_0= N/A mph (Exhibit 13-11)

S = 56.9 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-526 EB
Agency or Company	Atkins	Junction	3280-EB On from Long Point EB
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2018 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Freeway Number of Lanes, N: 2	☐ Yes ☐ On
☑ No ☐ Off	Ramp Number of Lanes, N: 1	☑ No ☐ Off
L_{up} = ft	Acceleration Lane Length, L_A: 625	L_{down} = ft
V_u = veh/h	Deceleration Lane Length L_D:	V_D = veh/h
	Freeway Volume, V_F: 2375	
	Ramp Volume, V_R: 588	
	Freeway Free-Flow Speed, S_{FF}: 65.0	
	Ramp Free-Flow Speed, S_{FR}: 45.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	2375	0.90	Level	11	0	0.948	1.00	2784
Ramp	588	0.90	Level	6	0	0.971	1.00	673
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 1.000 using Equation (Exhibit 13-6)

V_{12} = 2784 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	3457	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	3457	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = 28.2 (pc/mi/ln)

LOS = D (Exhibit 13-2)

Speed Determination

M_S = 0.388 (Exibit 13-11)

S_R= 56.1 mph (Exhibit 13-11)

S_0= N/A mph (Exhibit 13-11)

S = 56.1 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-526 EB*
Agency or Company	*Atkins*	From/To	*3290-LongPt.toUS17/Hungryneck*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2018 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*2652*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*9*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.957*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*65.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*65.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1540*	pc/h/ln
S	*64.7*	mph
D = v_p / S	*23.8*	pc/mi/ln
LOS	*C*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-526 EB*
Agency or Company	*Atkins*	From/To	*3290-LongPt.toUS17/Hungryneck*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*PM Peak*	Analysis Year	*2018 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*2963*	veh/h	Peak-Hour Factor, PHF	*0.90*	
AADT		veh/day	%Trucks and Buses, P_T	*7*	
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*	
Peak-Hr Direction Prop, D			General Terrain:	*Level*	
DDHV = AADT x K x D		veh/h	Grade % Length	*mi*	
			Up/Down %		

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.966*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*65.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*65.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1704*	pc/h/ln
S	*63.7*	mph
D = v_p / S	*26.8*	pc/mi/ln
LOS	*D*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-526 EB
Agency or Company	Atkins	Junction	3300-EB Off to US17/Hungryneck
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2018 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Freeway Number of Lanes, N	2	Downstream Adj Ramp	
☐ Yes	☐ On	Ramp Number of Lanes, N	1	☐ Yes	☐ On
☑ No	☐ Off	Acceleration Lane Length, L_A		☑ No	☐ Off
L_{up} =	ft	Deceleration Lane Length L_D	225	L_{down} =	ft
V_u =	veh/h	Freeway Volume, V_F	2652	V_D =	veh/h
		Ramp Volume, V_R	1147		
		Freeway Free-Flow Speed, S_{FF}	55.0		
		Ramp Free-Flow Speed, S_{FR}	45.0		

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	2652	0.90	Level	9	0	0.957	1.00	3079
Ramp	1147	0.90	Level	4	0	0.980	1.00	1300
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 1.000 using Equation (Exhibit 13-7)

V_{12} = 3079 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	3079	Exhibit 13-8	4500	No
$V_{FO} = V_F - V_R$	1779	Exhibit 13-8	4500	No
V_R	1300	Exhibit 13-10	2100	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	3079	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = 28.7 (pc/mi/ln)

LOS = D (Exhibit 13-2)

Speed Determination

D_s = 0.415 (Exhibit 13-12)

S_R= 49.6 mph (Exhibit 13-12)

S_0= N/A mph (Exhibit 13-12)

S = 49.6 mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-526 EB
Agency or Company	Atkins	Junction	3300-EB Off to US17/Hungryneck
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2018 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Freeway Number of Lanes, N	2	Downstream Adj Ramp	
☐ Yes	☐ On	Ramp Number of Lanes, N	1	☐ Yes	☐ On
☑ No	☐ Off	Acceleration Lane Length, L_A		☑ No	☐ Off
L_{up} =	ft	Deceleration Lane Length L_D	225	L_{down} =	ft
V_u =	veh/h	Freeway Volume, V_F	2963	V_D =	veh/h
		Ramp Volume, V_R	982		
		Freeway Free-Flow Speed, S_{FF}	55.0		
		Ramp Free-Flow Speed, S_{FR}	45.0		

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	2963	0.90	Level	7	0	0.966	1.00	3407
Ramp	982	0.90	Level	4	0	0.980	1.00	1113
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 1.000 using Equation (Exhibit 13-7)

V_{12} = 3407 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	3407	Exhibit 13-8	4500	No
$V_{FO} = V_F - V_R$	2294	Exhibit 13-8	4500	No
V_R	1113	Exhibit 13-10	2100	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	3407	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = 31.5 (pc/mi/ln)

LOS = D (Exhibit 13-2)

Speed Determination

D_s = 0.398 (Exhibit 13-12)

S_R= 49.8 mph (Exhibit 13-12)

S_0= N/A mph (Exhibit 13-12)

S = 49.8 mph (Exhibit 13-13)

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-526 EB*
Agency or Company	*Atkins*	From/To	*3310-US17/Hungryneck to US17*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2018 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*1505*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*6*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.971*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*55.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*55.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*861*	pc/h/ln
S	*55.0*	mph
D = v_p / S	*15.7*	pc/mi/ln
LOS	*B*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-526 EB*
Agency or Company	*Atkins*	From/To	*3310-US17/Hungryneck to US17*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*PM Peak*	Analysis Year	*2018 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*1981*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*5*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.976*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*55.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*55.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1128*	pc/h/ln
S	*55.0*	mph
D = v_p / S	*20.5*	pc/mi/ln
LOS	*C*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-526 EB
Agency or Company	Atkins	Junction	3320-EB Off to US17 SB
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2018 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Freeway Number of Lanes, N	2	Downstream Adj Ramp	
☐ Yes	☐ On	Ramp Number of Lanes, N	1	☐ Yes	☐ On
☑ No	☐ Off	Acceleration Lane Length, L_A		☑ No	☐ Off
L_{up} =	ft	Deceleration Lane Length L_D	250	L_{down} =	ft
V_u =	veh/h	Freeway Volume, V_F	1505	V_D =	veh/h
		Ramp Volume, V_R	1034		
		Freeway Free-Flow Speed, S_{FF}	55.0		
		Ramp Free-Flow Speed, S_{FR}	45.0		

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	1505	0.90	Level	6	0	0.971	1.00	1722
Ramp	1034	0.90	Level	10	0	0.952	1.00	1206
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 1.000 using Equation (Exhibit 13-7)

V_{12} = 1722 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	1722	Exhibit 13-8	4500	No
$V_{FO} = V_F - V_R$	516	Exhibit 13-8	4500	No
V_R	1206	Exhibit 13-10	2100	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	1722	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = 16.8 (pc/mi/ln)

LOS = B (Exhibit 13-2)

Speed Determination

D_s = 0.407 (Exhibit 13-12)

S_R= 49.7 mph (Exhibit 13-12)

S_0= N/A mph (Exhibit 13-12)

S = 49.7 mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-526 EB
Agency or Company	Atkins	Junction	3320-EB Off to US17 SB
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2018 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Freeway Number of Lanes, N	2	Downstream Adj Ramp	
☐ Yes	☐ On	Ramp Number of Lanes, N	1	☐ Yes	☐ On
☑ No	☐ Off	Acceleration Lane Length, L_A		☑ No	☐ Off
L_{up} =	ft	Deceleration Lane Length L_D	250	L_{down} =	ft
V_u =	veh/h	Freeway Volume, V_F	1981	V_D =	veh/h
		Ramp Volume, V_R	1013		
		Freeway Free-Flow Speed, S_{FF}	55.0		
		Ramp Free-Flow Speed, S_{FR}	45.0		

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	1981	0.90	Level	5	0	0.976	1.00	2256
Ramp	1013	0.90	Level	9	0	0.957	1.00	1176
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 1.000 using Equation (Exhibit 13-7)

V_{12} = 2256 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	2256	Exhibit 13-8	4500	No
$V_{FO} = V_F - V_R$	1080	Exhibit 13-8	4500	No
V_R	1176	Exhibit 13-10	2100	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	2256	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = 21.4 (pc/mi/ln)

LOS = C (Exhibit 13-2)

Speed Determination

D_s = 0.404 (Exhibit 13-12)

S_R= 49.8 mph (Exhibit 13-12)

S_0= N/A mph (Exhibit 13-12)

S = 49.8 mph (Exhibit 13-13)

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-526 EB*
Agency or Company	*Atkins*	From/To	*3325-US17 SB Off to US17 SB On*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2018 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*471*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*6*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.971*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*55.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*55.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*270*	pc/h/ln
S	*55.0*	mph
D = v_p / S	*4.9*	pc/mi/ln
LOS	*A*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-526 EB*
Agency or Company	*Atkins*	From/To	*3325-US17 SB Off to US17 SB On*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*PM Peak*	Analysis Year	*2018 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*968*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*5*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.976*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*55.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*55.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*551*	pc/h/ln
S	*55.0*	mph
D = v_p / S	*10.0*	pc/mi/ln
LOS	*A*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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F-2887

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-526 EB
Agency or Company	Atkins	Junction	3330-EB On from US17 SB
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2018 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Number of Lanes, N: 2	☐ Yes ☐ On
☑ No ☐ Off	Acceleration Lane Length, L_A: 725	☑ No ☐ Off
L_{up} = ft	Deceleration Lane Length L_D:	L_{down} = ft
V_u = veh/h	Freeway Volume, V_F: 471	V_D = veh/h
	Ramp Volume, V_R: 359	
	Freeway Free-Flow Speed, S_{FF}: 55.0	
	Ramp Free-Flow Speed, S_{FR}: 25.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	471	0.90	Level	6	0	0.971	1.00	539
Ramp	359	0.90	Level	3	0	0.985	1.00	405
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 1.000 using Equation (Exhibit 13-6)

V_{12} = 539 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	944	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	944	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = 8.1 (pc/mi/ln)

LOS = A (Exhibit 13-2)

Speed Determination

M_S = 0.295 (Exibit 13-11)

S_R= 51.2 mph (Exhibit 13-11)

S_0= N/A mph (Exhibit 13-11)

S = 51.2 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-526 EB
Agency or Company	Atkins	Junction	3330-EB On from US17 SB
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2018 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Number of Lanes, N: 2	☐ Yes ☐ On
☑ No ☐ Off	Acceleration Lane Length, L_A: 725	☑ No ☐ Off
L_{up} = ft	Deceleration Lane Length L_D:	L_{down} = ft
V_u = veh/h	Freeway Volume, V_F: 968	V_D = veh/h
	Ramp Volume, V_R: 290	
	Freeway Free-Flow Speed, S_{FF}: 55.0	
	Ramp Free-Flow Speed, S_{FR}: 25.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	968	0.90	Level	5	0	0.976	1.00	1102
Ramp	290	0.90	Level	3	0	0.985	1.00	327
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 1.000 using Equation (Exhibit 13-6)

V_{12} = 1102 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	1429	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	1429	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = 11.9 (pc/mi/ln)

LOS = B (Exhibit 13-2)

Speed Determination

M_S = 0.301 (Exibit 13-11)

S_R= 51.1 mph (Exhibit 13-11)

S_0= N/A mph (Exhibit 13-11)

S = 51.1 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-526 EB
Agency or Company	Atkins	Junction	3340-EB On from US17 NB
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2018 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Freeway Number of Lanes, N: 2	☐ Yes ☐ On
☑ No ☐ Off	Ramp Number of Lanes, N: 1	☑ No ☐ Off
L_{up} = ft	Acceleration Lane Length, L_A: 550	L_{down} = ft
V_u = veh/h	Deceleration Lane Length L_D:	V_D = veh/h
	Freeway Volume, V_F: 830	
	Ramp Volume, V_R: 24	
	Freeway Free-Flow Speed, S_{FF}: 55.0	
	Ramp Free-Flow Speed, S_{FR}: 45.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	830	0.90	Level	6	0	0.971	1.00	950
Ramp	24	0.90	Level	4	0	0.980	1.00	27
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 1.000 using Equation (Exhibit 13-6)

V_{12} = 950 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	977	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	977	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = 9.6 (pc/mi/ln)

LOS = A (Exhibit 13-2)

Speed Determination

M_S = 0.282 (Exibit 13-11)

S_R= 51.3 mph (Exhibit 13-11)

S_0= N/A mph (Exhibit 13-11)

S = 51.3 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-526 EB
Agency or Company	Atkins	Junction	3340-EB On from US17 NB
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2018 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Number of Lanes, N: 2	☐ Yes ☐ On
☑ No ☐ Off	Acceleration Lane Length, L_A: 550	☑ No ☐ Off
L_{up} = ft	Deceleration Lane Length L_D:	L_{down} = ft
V_u = veh/h	Freeway Volume, V_F: 1258	V_D = veh/h
	Ramp Volume, V_R: 32	
	Freeway Free-Flow Speed, S_{FF}: 55.0	
	Ramp Free-Flow Speed, S_{FR}: 45.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	1258	0.90	Level	5	0	0.976	1.00	1433
Ramp	32	0.90	Level	3	0	0.985	1.00	36
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 1.000 using Equation (Exhibit 13-6)

V_{12} = 1433 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	1469	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	1469	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = 13.5 (pc/mi/ln)

LOS = B (Exhibit 13-2)

Speed Determination

M_S = 0.288 (Exibit 13-11)

S_R= 51.3 mph (Exhibit 13-11)

S_0= N/A mph (Exhibit 13-11)

S = 51.3 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-526 WB
Agency or Company	Atkins	Junction	4010-WB Off to US17 NB
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2018 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Freeway Number of Lanes, N	2	Downstream Adj Ramp	
☐ Yes	☐ On	Ramp Number of Lanes, N	1	☐ Yes	☐ On
☑ No	☐ Off	Acceleration Lane Length, L_A		☑ No	☐ Off
L_{up} =	ft	Deceleration Lane Length L_D	300	L_{down} =	ft
V_u =	veh/h	Freeway Volume, V_F	1087	V_D =	veh/h
		Ramp Volume, V_R	312		
		Freeway Free-Flow Speed, S_{FF}	55.0		
		Ramp Free-Flow Speed, S_{FR}	45.0		

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	1087	0.90	Level	6	0	0.971	1.00	1244
Ramp	312	0.90	Level	13	0	0.939	1.00	369
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 1.000 using Equation (Exhibit 13-7)

V_{12} = 1244 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	1244	Exhibit 13-8	4500	No
$V_{FO} = V_F - V_R$	875	Exhibit 13-8	4500	No
V_R	369	Exhibit 13-10	2100	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	1244	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = 12.3 (pc/mi/ln)

LOS = B (Exhibit 13-2)

Speed Determination

D_s = 0.331 (Exhibit 13-12)

S_R= 50.7 mph (Exhibit 13-12)

S_0= N/A mph (Exhibit 13-12)

S = 50.7 mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-526 WB
Agency or Company	Atkins	Junction	4010-WB Off to US17 NB
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2018 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp
☐ Yes ☐ On
☑ No ☐ Off
L_{up} = ft
V_u = veh/h

Freeway Number of Lanes, N	2
Ramp Number of Lanes, N	1
Acceleration Lane Length, L_A	
Deceleration Lane Length L_D	300
Freeway Volume, V_F	1060
Ramp Volume, V_R	446
Freeway Free-Flow Speed, S_{FF}	55.0
Ramp Free-Flow Speed, S_{FR}	45.0

Downstream Adj Ramp
☐ Yes ☐ On
☑ No ☐ Off
L_{down} = ft
V_D = veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	1060	0.90	Level	5	0	0.976	1.00	1207
Ramp	446	0.90	Level	8	0	0.962	1.00	515
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)
P_{FM} = using Equation (Exhibit 13-6)
V_{12} = pc/h
V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)
Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No
Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No
If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = (pc/mi/ln)
LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)
S_R= mph (Exhibit 13-11)
S_0= mph (Exhibit 13-11)
S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)
P_{FD} = 1.000 using Equation (Exhibit 13-7)
V_{12} = 1207 pc/h
V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)
Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No
Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No
If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	1207	Exhibit 13-8	4500	No
$V_{FO} = V_F - V_R$	692	Exhibit 13-8	4500	No
V_R	515	Exhibit 13-10	2100	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	1207	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = 11.9 (pc/mi/ln)
LOS = B (Exhibit 13-2)

Speed Determination

D_s = 0.344 (Exhibit 13-12)
S_R= 50.5 mph (Exhibit 13-12)
S_0= N/A mph (Exhibit 13-12)
S = 50.5 mph (Exhibit 13-13)

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-526 WB*
Agency or Company	*Atkins*	From/To	*4015-US17 NB off to US17 NB On*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2018 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*775*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*6*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.971*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*55.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*55.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*443*	pc/h/ln
S	*55.0*	mph
D = v_p / S	*8.1*	pc/mi/ln
LOS	*A*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-526 WB*
Agency or Company	*Atkins*	From/To	*4015-US17 NB off to US17 NB On*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*PM Peak*	Analysis Year	*2018 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*614*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*5*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.976*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*55.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*55.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*350*	pc/h/ln
S	*55.0*	mph
D = v_p / S	*6.4*	pc/mi/ln
LOS	*A*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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F-2895

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-526 WB
Agency or Company	Atkins	Junction	4020-WB On from US17 NB
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2018 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Freeway Number of Lanes, N: 2	☐ Yes ☐ On
☑ No ☐ Off	Ramp Number of Lanes, N: 1	☑ No ☐ Off
L_{up} = ft	Acceleration Lane Length, L_A: 775	L_{down} = ft
V_u = veh/h	Deceleration Lane Length L_D:	V_D = veh/h
	Freeway Volume, V_F: 775	
	Ramp Volume, V_R: 907	
	Freeway Free-Flow Speed, S_{FF}: 55.0	
	Ramp Free-Flow Speed, S_{FR}: 25.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	775	0.90	Level	6	0	0.971	1.00	887
Ramp	907	0.90	Level	5	0	0.976	1.00	1033
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 1.000 using Equation (Exhibit 13-6)

V_{12} = 887 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	1920	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	1920	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = 15.1 (pc/mi/ln)

LOS = B (Exhibit 13-2)

Speed Determination

M_S = 0.309 (Exibit 13-11)

S_R= 51.0 mph (Exhibit 13-11)

S_0= N/A mph (Exhibit 13-11)

S = 51.0 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-526 WB
Agency or Company	Atkins	Junction	4020-WB On from US17 NB
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2018 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Freeway Number of Lanes, N: 2	☐ Yes ☐ On
☑ No ☐ Off	Ramp Number of Lanes, N: 1	☑ No ☐ Off
L_{up} = ft	Acceleration Lane Length, L_A: 775	L_{down} = ft
V_u = veh/h	Deceleration Lane Length L_D:	V_D = veh/h
	Freeway Volume, V_F: 614	
	Ramp Volume, V_R: 886	
	Freeway Free-Flow Speed, S_{FF}: 55.0	
	Ramp Free-Flow Speed, S_{FR}: 25.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	614	0.90	Level	5	0	0.976	1.00	699
Ramp	886	0.90	Level	4	0	0.980	1.00	1004
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 1.000 using Equation (Exhibit 13-6)

V_{12} = 699 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	1703	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	1703	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = 13.4 (pc/mi/ln)

LOS = B (Exhibit 13-2)

Speed Determination

M_S = 0.304 (Exibit 13-11)

S_R= 51.1 mph (Exhibit 13-11)

S_0= N/A mph (Exhibit 13-11)

S = 51.1 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-526 WB*
Agency or Company	*Atkins*	From/To	*4030-US17 to US17/Hungryneck*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2018 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*1682*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*6*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.971*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*55.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*55.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*962*	pc/h/ln
S	*55.0*	mph
D = v_p / S	*17.5*	pc/mi/ln
LOS	*B*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-526 WB*
Agency or Company	*Atkins*	From/To	*4030-US17 to US17/Hungryneck*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*PM Peak*	Analysis Year	*2018 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*1500*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*5*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.976*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*55.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*55.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*854*	pc/h/ln
S	*55.0*	mph
D = v_p / S	*15.5*	pc/mi/ln
LOS	*B*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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F-2899

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-526 WB
Agency or Company	Atkins	Junction	4040-WB On from US17/Hungrynec
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2018 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On		☐ Yes ☐ On
☑ No ☐ Off		☑ No ☐ Off
L_{up} = ft		L_{down} = ft
V_u = veh/h		V_D = veh/h

Freeway Number of Lanes, N	2
Ramp Number of Lanes, N	1
Acceleration Lane Length, L_A	425
Deceleration Lane Length L_D	
Freeway Volume, V_F	1682
Ramp Volume, V_R	853
Freeway Free-Flow Speed, S_{FF}	55.0
Ramp Free-Flow Speed, S_{FR}	45.0

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	1682	0.90	Level	6	0	0.971	1.00	1925
Ramp	853	0.90	Level	26	0	0.885	1.00	1071
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 1.000 using Equation (Exhibit 13-6)

V_{12} = 1925 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * $V_{12}/2$ ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	2996	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	2996	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = 25.7 (pc/mi/ln)

LOS = C (Exhibit 13-2)

Speed Determination

M_S = 0.361 (Exibit 13-11)

S_R= 50.3 mph (Exhibit 13-11)

S_0= N/A mph (Exhibit 13-11)

S = 50.3 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * $V_{12}/2$ ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-526 WB
Agency or Company	Atkins	Junction	4040-WB On from US17/Hungrynec
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2018 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On		☐ Yes ☐ On
☑ No ☐ Off		☑ No ☐ Off
L_{up} = ft		L_{down} = ft
V_u = veh/h		V_D = veh/h

Freeway Number of Lanes, N	2
Ramp Number of Lanes, N	1
Acceleration Lane Length, L_A	425
Deceleration Lane Length L_D	
Freeway Volume, V_F	1500
Ramp Volume, V_R	1233
Freeway Free-Flow Speed, S_{FF}	55.0
Ramp Free-Flow Speed, S_{FR}	45.0

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	1500	0.90	Level	5	0	0.976	1.00	1708
Ramp	1233	0.90	Level	15	0	0.930	1.00	1473
UpStream								
DownStream								

Estimation of v_{12}

Merge Areas

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 1.000 using Equation (Exhibit 13-6)

V_{12} = 1708 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * $V_{12}/2$ ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Diverge Areas

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * $V_{12}/2$ ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	3181	Exhibit 13-8		No

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	3181	Exhibit 13-8	4600:All	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = 26.9 (pc/mi/ln)

LOS = C (Exhibit 13-2)

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = 0.377 (Exibit 13-11)

S_R= 50.1 mph (Exhibit 13-11)

S_0= N/A mph (Exhibit 13-11)

S = 50.1 mph (Exhibit 13-13)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-526 WB*
Agency or Company	*Atkins*	From/To	*4050-US17/Hungryneck to LongPt*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2018 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*2535*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*9*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.957*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*65.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*65.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1472*	pc/h/ln
S	*64.9*	mph
D = v_p / S	*22.7*	pc/mi/ln
LOS	*C*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-526 WB*
Agency or Company	*Atkins*	From/To	*4050-US17/Hungryneck to LongPt*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*PM Peak*	Analysis Year	*2018 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*2733*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*7*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.966*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*65.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*65.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1571*	pc/h/ln
S	*64.6*	mph
D = v_p / S	*24.3*	pc/mi/ln
LOS	*C*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-526 WB
Agency or Company	Atkins	Junction	4060-WB Off to Long Point
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2018 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Freeway Number of Lanes, N: 2	☐ Yes ☐ On
☑ No ☐ Off	Ramp Number of Lanes, N: 1	☑ No ☐ Off
L_{up} = ft	Acceleration Lane Length, L_A	L_{down} = ft
V_u = veh/h	Deceleration Lane Length L_D: 250	V_D = veh/h
	Freeway Volume, V_F: 2535	
	Ramp Volume, V_R: 516	
	Freeway Free-Flow Speed, S_{FF}: 65.0	
	Ramp Free-Flow Speed, S_{FR}: 45.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	2535	0.90	Level	9	0	0.957	1.00	2943
Ramp	516	0.90	Level	16	0	0.926	1.00	619
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 1.000 using Equation (Exhibit 13-7)

V_{12} = 2943 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	2943	Exhibit 13-8	4700	No
$V_{FO} = V_F - V_R$	2324	Exhibit 13-8	4700	No
V_R	619	Exhibit 13-10	2100	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	2943	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = 27.3 (pc/mi/ln)

LOS = C (Exhibit 13-2)

Speed Determination

D_s = 0.354 (Exhibit 13-12)

S_R= 56.9 mph (Exhibit 13-12)

S_0= N/A mph (Exhibit 13-12)

S = 56.9 mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-526 WB
Agency or Company	Atkins	Junction	4060-WB Off to Long Point
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2018 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp
☐ Yes ☐ On
☑ No ☐ Off
L_{up} = ft
V_u = veh/h

Freeway Number of Lanes, N	2
Ramp Number of Lanes, N	1
Acceleration Lane Length, L_A	
Deceleration Lane Length L_D	250
Freeway Volume, V_F	2733
Ramp Volume, V_R	1177
Freeway Free-Flow Speed, S_{FF}	65.0
Ramp Free-Flow Speed, S_{FR}	45.0

Downstream Adj Ramp
☐ Yes ☐ On
☑ No ☐ Off
L_{down} = ft
V_D = veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	2733	0.90	Level	7	0	0.966	1.00	3143
Ramp	1177	0.90	Level	6	0	0.971	1.00	1347
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)
P_{FM} = using Equation (Exhibit 13-6)
V_{12} = pc/h
V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)
Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No
Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No
If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = (pc/mi/ln)
LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)
S_R= mph (Exhibit 13-11)
S_0= mph (Exhibit 13-11)
S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)
P_{FD} = 1.000 using Equation (Exhibit 13-7)
V_{12} = 3143 pc/h
V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)
Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No
Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No
If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	3143	Exhibit 13-8	4700	No
$V_{FO} = V_F - V_R$	1796	Exhibit 13-8	4700	No
V_R	1347	Exhibit 13-10	2100	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	3143	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = 29.0 (pc/mi/ln)
LOS = D (Exhibit 13-2)

Speed Determination

D_s = 0.419 (Exhibit 13-12)
S_R= 55.4 mph (Exhibit 13-12)
S_0= N/A mph (Exhibit 13-12)
S = 55.4 mph (Exhibit 13-13)

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-526 WB*
Agency or Company	*Atkins*	From/To	*4065-LongPt Off to LongPtEB On*
Date Performed	*4/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2018 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*2019*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*12*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.943*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*65.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*65.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1189*	pc/h/ln
S	*65.0*	mph
D = v_p / S	*18.3*	pc/mi/ln
LOS	*C*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-526 WB*
Agency or Company	*Atkins*	From/To	*4065-LongPt Off to LongPtEB On*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*PM Peak*	Analysis Year	*2018 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*1556*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*11*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.948*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*65.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*65.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*912*	pc/h/ln
S	*65.0*	mph
D = v_p / S	*14.0*	pc/mi/ln
LOS	*B*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-526 WB
Agency or Company	Atkins	Junction	4070-WB On from Long Point EB
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2018 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Freeway Number of Lanes, N: 2	☐ Yes ☐ On
☑ No ☐ Off	Ramp Number of Lanes, N: 1	☑ No ☐ Off
L_{up} = ft	Acceleration Lane Length, L_A: 950	L_{down} = ft
V_u = veh/h	Deceleration Lane Length L_D:	V_D = veh/h
	Freeway Volume, V_F: 2019	
	Ramp Volume, V_R: 601	
	Freeway Free-Flow Speed, S_{FF}: 65.0	
	Ramp Free-Flow Speed, S_{FR}: 25.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	2019	0.90	Level	12	0	0.943	1.00	2378
Ramp	601	0.90	Level	21	0	0.905	1.00	738
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 1.000 using Equation (Exhibit 13-6)

V_{12} = 2378 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	3116	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	3116	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = 23.5 (pc/mi/ln)

LOS = C (Exhibit 13-2)

Speed Determination

M_S = 0.361 (Exibit 13-11)

S_R= 56.7 mph (Exhibit 13-11)

S_0= N/A mph (Exhibit 13-11)

S = 56.7 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-526 WB
Agency or Company	Atkins	Junction	4070-WB On from Long Point EB
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2018 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Freeway Number of Lanes, N: 2	☐ Yes ☐ On
☑ No ☐ Off	Ramp Number of Lanes, N: 1	☑ No ☐ Off
L_{up} = ft	Acceleration Lane Length, L_A: 950	L_{down} = ft
V_u = veh/h	Deceleration Lane Length L_D:	V_D = veh/h
	Freeway Volume, V_F: 1556	
	Ramp Volume, V_R: 668	
	Freeway Free-Flow Speed, S_{FF}: 65.0	
	Ramp Free-Flow Speed, S_{FR}: 25.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	1556	0.90	Level	11	0	0.948	1.00	1824
Ramp	668	0.90	Level	16	0	0.926	1.00	802
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 1.000 using Equation (Exhibit 13-6)

V_{12} = 1824 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	2626	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	2626	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = 19.6 (pc/mi/ln)

LOS = B (Exhibit 13-2)

Speed Determination

M_S = 0.327 (Exibit 13-11)

S_R= 57.5 mph (Exhibit 13-11)

S_0= N/A mph (Exhibit 13-11)

S = 57.5 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-526 WB
Agency or Company	Atkins	Junction	4080-WB On from Long Point WB
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2018 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Freeway Number of Lanes, N: 2	☐ Yes ☐ On
☑ No ☐ Off	Ramp Number of Lanes, N: 1	☑ No ☐ Off
L_{up} = ft	Acceleration Lane Length, L_A: 1025	L_{down} = ft
V_u = veh/h	Deceleration Lane Length L_D:	V_D = veh/h
	Freeway Volume, V_F: 2620	
	Ramp Volume, V_R: 1408	
	Freeway Free-Flow Speed, S_{FF}: 65.0	
	Ramp Free-Flow Speed, S_{FR}: 45.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	2620	0.90	Level	12	0	0.943	1.00	3086
Ramp	1408	0.90	Level	6	0	0.971	1.00	1611
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 1.000 using Equation (Exhibit 13-6)

V_{12} = 3086 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	4697	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	4697	Exhibit 13-8	4600:All	Yes

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = 34.9 (pc/mi/ln)

LOS = D (Exhibit 13-2)

Speed Determination

M_S = 0.656 (Exibit 13-11)

S_R= 49.9 mph (Exhibit 13-11)

S_0= N/A mph (Exhibit 13-11)

S = 49.9 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-526 WB
Agency or Company	Atkins	Junction	4080-WB On from Long Point WB
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2018 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Freeway Number of Lanes, N: 2	☐ Yes ☐ On
☑ No ☐ Off	Ramp Number of Lanes, N: 1	☑ No ☐ Off
L_{up} = ft	Acceleration Lane Length, L_A: 1025	L_{down} = ft
V_u = veh/h	Deceleration Lane Length L_D:	V_D = veh/h
	Freeway Volume, V_F: 2224	
	Ramp Volume, V_R: 1022	
	Freeway Free-Flow Speed, S_{FF}: 65.0	
	Ramp Free-Flow Speed, S_{FR}: 45.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	2224	0.90	Level	11	0	0.948	1.00	2607
Ramp	1022	0.90	Level	8	0	0.962	1.00	1181
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 1.000 using Equation (Exhibit 13-6)

V_{12} = 2607 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	3788	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	3788	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = 28.1 (pc/mi/ln)

LOS = D (Exhibit 13-2)

Speed Determination

M_S = 0.401 (Exibit 13-11)

S_R= 55.8 mph (Exhibit 13-11)

S_0= N/A mph (Exhibit 13-11)

S = 55.8 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-526 WB*
Agency or Company	*Atkins*	From/To	*4090-Long Point to Island Park*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2018 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*4028*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*12*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.943*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*65.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*65.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*2372*	pc/h/ln
S	*51.6*	mph
D = v_p / S	*46.0*	pc/mi/ln
LOS	*F*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-526 WB*
Agency or Company	*Atkins*	From/To	*4090-Long Point to Island Park*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*PM Peak*	Analysis Year	*2018 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*3246*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*11*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.948*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*65.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*65.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1903*	pc/h/ln
S	*61.4*	mph
D = v_p / S	*31.0*	pc/mi/ln
LOS	*D*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-526 WB
Agency or Company	Atkins	Junction	4100-WB Off to Island Park
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2018 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Number of Lanes, N	2	Downstream Adj Ramp	
☐ Yes	☐ On	Acceleration Lane Length, L_A		☐ Yes	☐ On
☑ No	☐ Off	Deceleration Lane Length L_D	775	☑ No	☐ Off
L_{up} =	ft	Freeway Volume, V_F	4028	L_{down} =	ft
V_u =	veh/h	Ramp Volume, V_R	1099	V_D =	veh/h
		Freeway Free-Flow Speed, S_{FF}	65.0		
		Ramp Free-Flow Speed, S_{FR}	25.0		

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	4028	0.90	Level	12	0	0.943	1.00	4744
Ramp	1099	0.90	Level	10	0	0.952	1.00	1282
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 1.000 using Equation (Exhibit 13-7)

V_{12} = 4744 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	4744	Exhibit 13-8	4700	Yes
$V_{FO} = V_F - V_R$	3462	Exhibit 13-8	4700	No
V_R	1282	Exhibit 13-10	1900	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	4744	Exhibit 13-8	4400:All	Yes

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = 38.1 (pc/mi/ln)

LOS = F (Exhibit 13-2)

Speed Determination

D_s = 0.673 (Exhibit 13-12)

S_R= 49.5 mph (Exhibit 13-12)

S_0= N/A mph (Exhibit 13-12)

S = 49.5 mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-526 WB
Agency or Company	Atkins	Junction	4100-WB Off to Island Park
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2018 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Number of Lanes, N	2	Downstream Adj Ramp	
☐ Yes	☐ On	Acceleration Lane Length, L_A		☐ Yes	☐ On
☑ No	☐ Off	Deceleration Lane Length L_D	775	☑ No	☐ Off
L_{up} =	ft	Freeway Volume, V_F	3246	L_{down} =	ft
V_u =	veh/h	Ramp Volume, V_R	595	V_D =	veh/h
		Freeway Free-Flow Speed, S_{FF}	65.0		
		Ramp Free-Flow Speed, S_{FR}	25.0		

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	3246	0.90	Level	11	0	0.948	1.00	3805
Ramp	595	0.90	Level	16	0	0.926	1.00	714
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 1.000 using Equation (Exhibit 13-7)

V_{12} = 3805 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	3805	Exhibit 13-8	4700	No
$V_{FO} = V_F - V_R$	3091	Exhibit 13-8	4700	No
V_R	714	Exhibit 13-10	1900	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	3805	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = 30.0 (pc/mi/ln)

LOS = D (Exhibit 13-2)

Speed Determination

D_s = 0.622 (Exhibit 13-12)

S_R= 50.7 mph (Exhibit 13-12)

S_0= N/A mph (Exhibit 13-12)

S = 50.7 mph (Exhibit 13-13)

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-526 WB*
Agency or Company	*Atkins*	From/To	*4105 - Is. Pk Off to Is. Pk On*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2018 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*2929*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*12*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.943*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*65.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*65.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1725*	pc/h/ln
S	*63.5*	mph
D = v_p / S	*27.2*	pc/mi/ln
LOS	*D*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-526 WB*
Agency or Company	*Atkins*	From/To	*4105 - Is. Pk Off to Is. Pk On*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*PM Peak*	Analysis Year	*2018 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*2651*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*11*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.948*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*65.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*65.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1554*	pc/h/ln
S	*64.7*	mph
D = v_p / S	*24.0*	pc/mi/ln
LOS	*C*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-526 WB
Agency or Company	Atkins	Junction	4110-WB On from Island Park Dr
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2018 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Number of Lanes, N: 2	☐ Yes ☐ On
☑ No ☐ Off	Acceleration Lane Length, L_A: 1400	☑ No ☐ Off
L_{up} = ft	Deceleration Lane Length L_D:	L_{down} = ft
V_u = veh/h	Freeway Volume, V_F: 2929	V_D = veh/h
	Ramp Volume, V_R: 583	
	Freeway Free-Flow Speed, S_{FF}: 65.0	
	Ramp Free-Flow Speed, S_{FR}: 45.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	2929	0.90	Level	12	0	0.943	1.00	3450
Ramp	583	0.90	Level	7	0	0.966	1.00	670
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 1.000 using Equation (Exhibit 13-6)

V_{12} = 3450 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	4120	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	4120	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = 28.5 (pc/mi/ln)

LOS = D (Exhibit 13-2)

Speed Determination

M_S = 0.435 (Exibit 13-11)

S_R= 55.0 mph (Exhibit 13-11)

S_0= N/A mph (Exhibit 13-11)

S = 55.0 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-526 WB
Agency or Company	Atkins	Junction	4110-WB On from Island Park Dr
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2018 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Number of Lanes, N: 2	☐ Yes ☐ On
☑ No ☐ Off	Acceleration Lane Length, L_A: 1400	☑ No ☐ Off
L_{up} = ft	Deceleration Lane Length L_D:	L_{down} = ft
V_u = veh/h	Freeway Volume, V_F: 2651	V_D = veh/h
	Ramp Volume, V_R: 676	
	Freeway Free-Flow Speed, S_{FF}: 65.0	
	Ramp Free-Flow Speed, S_{FR}: 45.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	2651	0.90	Level	11	0	0.948	1.00	3108
Ramp	676	0.90	Level	5	0	0.976	1.00	770
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 1.000 using Equation (Exhibit 13-6)

V_{12} = 3108 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	3878	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	3878	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = 26.6 (pc/mi/ln)

LOS = C (Exhibit 13-2)

Speed Determination

M_S = 0.383 (Exibit 13-11)

S_R= 56.2 mph (Exhibit 13-11)

S_0= N/A mph (Exhibit 13-11)

S = 56.2 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-526 WB*
Agency or Company	*Atkins*	From/To	*4120-IslandParktoClementsFerry*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2018 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*3512*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*10*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.952*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*65.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*65.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*2049*	pc/h/ln
S	*59.0*	mph
D = v_p / S	*34.7*	pc/mi/ln
LOS	*D*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-526 WB*
Agency or Company	*Atkins*	From/To	*4120-IslandParktoClementsFerry*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*PM Peak*	Analysis Year	*2018 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*3327*	veh/h	Peak-Hour Factor, PHF	*0.90*	
AADT		veh/day	%Trucks and Buses, P_T	*9*	
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*	
Peak-Hr Direction Prop, D			General Terrain:	*Level*	
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*	

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.957*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*65.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*65.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1932*	pc/h/ln
S	*61.0*	mph
D = v_p / S	*31.7*	pc/mi/ln
LOS	*D*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-526 WB
Agency or Company	Atkins	Junction	4130-WB Off to Clements Ferry
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2018 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On		☐ Yes ☐ On
☑ No ☐ Off		☑ No ☐ Off
L_{up} = ft		L_{down} = ft
V_u = veh/h		V_D = veh/h

Number of Lanes, N	2
Acceleration Lane Length, L_A	
Deceleration Lane Length L_D	240
Freeway Volume, V_F	3512
Ramp Volume, V_R	444
Freeway Free-Flow Speed, S_{FF}	60.0
Ramp Free-Flow Speed, S_{FR}	45.0

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	3512	0.90	Level	10	0	0.952	1.00	4097
Ramp	444	0.90	Level	17	0	0.922	1.00	535
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 1.000 using Equation (Exhibit 13-7)

V_{12} = 4097 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	4097	Exhibit 13-8	4600	No
$V_{FO} = V_F - V_R$	3562	Exhibit 13-8	4600	No
V_R	535	Exhibit 13-10	2100	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	4097	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = 37.3 (pc/mi/ln)

LOS = E (Exhibit 13-2)

Speed Determination

D_s = 0.346 (Exhibit 13-12)

S_R= 53.8 mph (Exhibit 13-12)

S_0= N/A mph (Exhibit 13-12)

S = 53.8 mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-526 WB
Agency or Company	Atkins	Junction	4130-WB Off to Clements Ferry
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2018 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Number of Lanes, N: 2	☐ Yes ☐ On
☑ No ☐ Off	Acceleration Lane Length, L_A:	☑ No ☐ Off
L_{up} = ft	Deceleration Lane Length L_D: 240	L_{down} = ft
V_u = veh/h	Freeway Volume, V_F: 3327	V_D = veh/h
	Ramp Volume, V_R: 368	
	Freeway Free-Flow Speed, S_{FF}: 60.0	
	Ramp Free-Flow Speed, S_{FR}: 45.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	3327	0.90	Level	9	0	0.957	1.00	3863
Ramp	368	0.90	Level	17	0	0.922	1.00	444
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 1.000 using Equation (Exhibit 13-7)

V_{12} = 3863 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	3863	Exhibit 13-8	4600	No
$V_{FO} = V_F - V_R$	3419	Exhibit 13-8	4600	No
V_R	444	Exhibit 13-10	2100	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	3863	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = 35.3 (pc/mi/ln)

LOS = E (Exhibit 13-2)

Speed Determination

D_s = 0.338 (Exhibit 13-12)

S_R= 53.9 mph (Exhibit 13-12)

S_0= N/A mph (Exhibit 13-12)

S = 53.9 mph (Exhibit 13-13)

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-526 WB*
Agency or Company	*Atkins*	From/To	*4135-ClFerry Off to ClFerry On*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2018 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*3068*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*12*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.943*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*60.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*60.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1807*	pc/h/ln
S	*59.2*	mph
D = v_p / S	*30.5*	pc/mi/ln
LOS	*D*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-526 WB*
Agency or Company	*Atkins*	From/To	*4135-ClFerry Off to ClFerry On*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*PM Peak*	Analysis Year	*2018 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*2959*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*12*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.943*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*60.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*60.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1743*	pc/h/ln
S	*59.6*	mph
D = v_p / S	*29.2*	pc/mi/ln
LOS	*D*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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FREEWAY RAMP ADD OR DROP LANE ANALYSIS

ATKINS

General Information

Date Performed:	7/25/2014	Freeway/Direction	I-526 WB
Analysis Year	2018 No Action	Junction	From Clements Ferry
Analysis Time Period:	AM Peak	Segment ID	4140
Project Description:	Navy Base ICTF		

Inputs

	Freeway Upstream of Ramp	Freeway Downstream of Ramp	Ramp
Number of Lanes, N	2	3	1
Free-Flow Speed, FFS (mph)	60	60	45
Volume, V (veh/h)	3,068	4,029	961
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	12%	12%	20%
%RVs, P_R	0%	0%	0%

Performance Measures

	Freeway Upstream Ramp	Freeway Downstream Ramp	Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.94	0.94	0.91
Demand Flow Rate, v_p (pc/h/ln)	1,807	1,582	1,175
Capacity Flow Rate, c (pc/h/ln)	2,300	2,300	2,100
v/c ratio	0.79	0.69	0.56
Density, D_{MD} (pc/mi/ln)	31.6	27.7	20.6
LOS	D	C	C

Formulas and Reference Material

$$f_{HV} = \frac{1}{1 + P_T(E_T-1)+P_R(E_R-1)}$$ HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P}$$ HCM 2010, Equation 11-2

$$D_{MD} = \frac{0.0175*v_f}{N}$$ HCM 2010, Equation 13-26

Basic Freeway Segments Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
75	2,400
70	2,400
65	2,350
60	2,300
55	2,250

Source: HCM 2010, Exhibit 11-17

Ramp Roadways Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

Diverge LOS Thresholds

LOS	Density (pc/mi/ln)
A	≤10
B	>10-20
C	>20-28
D	>28-35
E	>35
F	v/c > 1

Source: HCM 2010, Exhibit 13-2

FREEWAY RAMP ADD OR DROP LANE ANALYSIS

ATKINS

General Information

Date Performed:	7/25/2014	Freeway/Direction	I-526 WB
Analysis Year	2018 No Action	Junction	From Clements Ferry
Analysis Time Period:	PM Peak	Segment ID	4140
Project Description:	Navy Base ICTF		

Inputs

	Freeway Upstream of Ramp	Freeway Downstream of Ramp	Ramp
Number of Lanes, N	2	3	1
Free-Flow Speed, FFS (mph)	60	60	45
Volume, V (veh/h)	2,959	3,315	356
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	12%	12%	47%
%RVs, P_R	0%	0%	0%

Performance Measures

	Freeway Upstream Ramp	Freeway Downstream Ramp	Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.94	0.94	0.81
Demand Flow Rate, v_p (pc/h/ln)	1,743	1,301	489
Capacity Flow Rate, c (pc/h/ln)	2,300	2,300	2,100
v/c ratio	0.76	0.57	0.23
Density, D_{MD} (pc/mi/ln)	30.5	22.8	8.6
LOS	D	C	A

Formulas and Reference Material

$$f_{HV} = \frac{1}{1 + P_T(E_T-1)+P_R(E_R-1)}$$ HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P}$$ HCM 2010, Equation 11-2

$$D_{MD} = \frac{0.0175*v_f}{N}$$ HCM 2010, Equation 13-26

Basic Freeway Segments Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
75	2,400
70	2,400
65	2,350
60	2,300
55	2,250

Source: HCM 2010, Exhibit 11-17

Ramp Roadways Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

Diverge LOS Thresholds

LOS	Density (pc/mi/ln)
A	≤10
B	>10-20
C	>20-28
D	>28-35
E	>35
F	v/c > 1

Source: HCM 2010, Exhibit 13-2

BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-526 WB*
Agency or Company	*Atkins*	From/To	*4150-ClementsFerry to Virginia*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2018 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*4029*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*12*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.943*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*60.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*60.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*2373*	pc/h/ln
S	*49.1*	mph
D = v_p / S	*48.3*	pc/mi/ln
LOS	*F*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-526 WB*
Agency or Company	*Atkins*	From/To	*4150-ClementsFerry to Virginia*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*PM Peak*	Analysis Year	*2018 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*3315*	veh/h	Peak-Hour Factor, PHF	*0.90*	
AADT		veh/day	%Trucks and Buses, P_T	*12*	
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*	
Peak-Hr Direction Prop, D			General Terrain:	*Level*	
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*	

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.943*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*60.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*60.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1952*	pc/h/ln
S	*57.7*	mph
D = v_p / S	*33.8*	pc/mi/ln
LOS	*D*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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Navy Base ICTF

FREEWAY WEAVING WORKSHEET

General Information

Analyst	AJR
Agency/Company	Atkins
Date Performed	7/25/2014
Analysis Time Period	AM Peak

Site Information

Freeway/Dir of Travel	I-526 WB
Weaving Segment Location	4160 - Virginia to Rhett
Analysis Year	2018 No Action

Project Description *Navy Base ICTF*

Inputs

Weaving configuration	One-Sided	Segment type	Freeway
Weaving number of lanes, N	3	Freeway minimum speed, S_{MIN}	15
Weaving segment length, L_S	1415ft	Freeway maximum capacity, C_{IFL}	2300
Freeway free-flow speed, FFS	60 mph	Terrain type	Level

Conversions to pc/h Under Base Conditions

	V (veh/h)	PHF	Truck (%)	RV (%)	E_T	E_R	f_{HV}	f_p	v (pc/h)
V_{FF}	2980	0.90	15	0	1.5	1.2	0.930	1.00	3559
V_{RF}	98	0.90	85	0	1.5	1.2	0.702	1.00	155
V_{FR}	1049	0.90	15	0	1.5	1.2	0.930	1.00	1253
V_{RR}	34	0.90	85	0	1.5	1.2	0.702	1.00	54
V_{NW}	3613							V =	5021
V_W	1408								
VR	0.280								

Configuration Characteristics

Minimum maneuver lanes, N_{WL}	2 lc	Minimum weaving lane changes, LC_{MIN}	1408 lc/h
Interchange density, ID	0.7 int/mi	Weaving lane changes, LC_W	1587 lc/h
Minimum RF lane changes, LC_{RF}	1 lc/pc	Non-weaving lane changes, LC_{NW}	933 lc/h
Minimum FR lane changes, LC_{FR}	1 lc/pc	Total lane changes, LC_{ALL}	2520 lc/h
Minimum RR lane changes, LC_{RR}	lc/pc	Non-weaving vehicle index, I_{NW}	358

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment flow rate, v	5021 pc/h	Weaving intensity factor, W	0.356
Weaving segment capacity, c_w	5573 veh/h	Weaving segment speed, S	43.4 mph
Weaving segment v/c ratio	0.838	Average weaving speed, S_W	48.2 mph
Weaving segment density, D	38.5 pc/mi/ln	Average non-weaving speed, S_{NW}	41.8 mph
Level of Service, LOS	E	Maximum weaving length, L_{MAX}	5375 ft

Notes

a. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments".
b. For volumes that exceed the weaving segment capacity, the level of service is "F".

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Navy Base ICTF

FREEWAY WEAVING WORKSHEET

General Information

Analyst	AJR
Agency/Company	Atkins
Date Performed	7/25/2014
Analysis Time Period	PM Peak

Site Information

Freeway/Dir of Travel	I-526 WB
Weaving Segment Location	4160 - Virginia to Rhett
Analysis Year	2018 No Action

Project Description *Navy Base ICTF*

Inputs

Weaving configuration	One-Sided	Segment type	Freeway
Weaving number of lanes, N	3	Freeway minimum speed, S_{MIN}	15
Weaving segment length, L_S	1415ft	Freeway maximum capacity, C_{IFL}	2300
Freeway free-flow speed, FFS	60 mph	Terrain type	Level

Conversions to pc/h Under Base Conditions

	V (veh/h)	PHF	Truck (%)	RV (%)	E_T	E_R	f_{HV}	f_p	v (pc/h)
V_{FF}	2319	0.90	14	0	1.5	1.2	0.935	1.00	2757
V_{RF}	587	0.90	14	0	1.5	1.2	0.935	1.00	698
V_{FR}	996	0.90	14	0	1.5	1.2	0.935	1.00	1184
V_{RR}	253	0.90	11	0	1.5	1.2	0.948	1.00	297
V_{NW}	3054							V =	4936
V_W	1882								
VR	0.381								

Configuration Characteristics

Minimum maneuver lanes, N_{WL}	2 lc	Minimum weaving lane changes, LC_{MIN}	1882 lc/h
Interchange density, ID	0.7 int/mi	Weaving lane changes, LC_W	2061 lc/h
Minimum RF lane changes, LC_{RF}	1 lc/pc	Non-weaving lane changes, LC_{NW}	818 lc/h
Minimum FR lane changes, LC_{FR}	1 lc/pc	Total lane changes, LC_{ALL}	2879 lc/h
Minimum RR lane changes, LC_{RR}	lc/pc	Non-weaving vehicle index, I_{NW}	302

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment flow rate, v	4936 pc/h	Weaving intensity factor, W	0.396
Weaving segment capacity, c_w	5364 veh/h	Weaving segment speed, S	41.5 mph
Weaving segment v/c ratio	0.860	Average weaving speed, S_W	47.2 mph
Weaving segment density, D	39.7 pc/mi/ln	Average non-weaving speed, S_{NW}	38.6 mph
Level of Service, LOS	E	Maximum weaving length, L_{MAX}	6472 ft

Notes

a. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments".
b. For volumes that exceed the weaving segment capacity, the level of service is "F".

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-526 WB*
Agency or Company	*Atkins*	From/To	*4165-Rhett Off to Rhett On*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2018 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*3078*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*16*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.926*

Speed Inputs			Calc Speed Adj and FFS		
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f_{LW}		mph
Number of Lanes, N	*2*		f_{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	*60.0*	mph	FFS	*60.0*	mph
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures			Design (N)	
Operational (LOS)			Design (N)	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1847*	pc/h/ln	Design LOS	
			v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h/ln
S	*58.9*	mph	S	mph
D = v_p / S	*31.4*	pc/mi/ln	D = v_p / S	pc/mi/ln
LOS	*D*		Required Number of Lanes, N	

Glossary		Factor Location	
N - Number of lanes	S - Speed	E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
V - Hourly volume	D - Density	E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 11-18	TRD - Page 11-11
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 11-2, 11-3	
DDHV - Directional design hour volume			

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F-2932

BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-526 WB*
Agency or Company	*Atkins*	From/To	*4165-Rhett Off to Rhett On*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*PM Peak*	Analysis Year	*2018 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*2906*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*15*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.930*

Speed Inputs			Calc Speed Adj and FFS		
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f_{LW}		mph
Number of Lanes, N	*2*		f_{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	*60.0*	mph	FFS	*60.0*	mph
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures			Design (N)	
Operational (LOS)			Design (N)	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1736*	pc/h/ln	Design LOS	
			v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h/ln
S	*59.7*	mph	S	mph
D = v_p / S	*29.1*	pc/mi/ln	D = v_p / S	pc/mi/ln
LOS	*D*		Required Number of Lanes, N	

Glossary		Factor Location	
N - Number of lanes	S - Speed	E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
V - Hourly volume	D - Density	E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 11-18	TRD - Page 11-11
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 11-2, 11-3	
DDHV - Directional design hour volume			

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-526 WB
Agency or Company	Atkins	Junction	4170-WB On from Rhett
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2018 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Freeway Number of Lanes, N: 2	☐ Yes ☐ On
☑ No ☐ Off	Ramp Number of Lanes, N: 1	☑ No ☐ Off
L_{up} = ft	Acceleration Lane Length, L_A: 625	L_{down} = ft
V_u = veh/h	Deceleration Lane Length L_D:	V_D = veh/h
	Freeway Volume, V_F: 3078	
	Ramp Volume, V_R: 709	
	Freeway Free-Flow Speed, S_{FF}: 60.0	
	Ramp Free-Flow Speed, S_{FR}: 45.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	3078	0.90	Level	16	0	0.926	1.00	3694
Ramp	709	0.90	Level	7	0	0.966	1.00	815
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 1.000 using Equation (Exhibit 13-6)

V_{12} = 3694 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	4509	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	4509	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = 36.4 (pc/mi/ln)

LOS = E (Exhibit 13-2)

Speed Determination

M_S = 0.619 (Exibit 13-11)

S_R= 48.9 mph (Exhibit 13-11)

S_0= N/A mph (Exhibit 13-11)

S = 48.9 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-526 WB
Agency or Company	Atkins	Junction	4170-WB On from Rhett
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2018 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Freeway Number of Lanes, N: 2	☐ Yes ☐ On
☑ No ☐ Off	Ramp Number of Lanes, N: 1	☑ No ☐ Off
L_{up} = ft	Acceleration Lane Length, L_A: 625	L_{down} = ft
V_u = veh/h	Deceleration Lane Length L_D:	V_D = veh/h
	Freeway Volume, V_F: 2906	
	Ramp Volume, V_R: 579	
	Freeway Free-Flow Speed, S_{FF}: 60.0	
	Ramp Free-Flow Speed, S_{FR}: 45.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	2906	0.90	Level	15	0	0.930	1.00	3471
Ramp	579	0.90	Level	7	0	0.966	1.00	666
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 1.000 using Equation (Exhibit 13-6)

V_{12} = 3471 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	4137	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	4137	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = 33.5 (pc/mi/ln)

LOS = D (Exhibit 13-2)

Speed Determination

M_S = 0.509 (Exibit 13-11)

S_R= 50.8 mph (Exhibit 13-11)

S_0= N/A mph (Exhibit 13-11)

S = 50.8 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-526 WB*
Agency or Company	*Atkins*	From/To	*4180-Rhett to Rivers*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2018 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*3787*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*16*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.926*

Speed Inputs			Calc Speed Adj and FFS		
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f_{LW}		mph
Number of Lanes, N	*2*		f_{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	*55.0*	mph	FFS	*55.0*	mph
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures			Design (N)	
Operational (LOS)			Design (N)	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*2272*	pc/h/ln	Design LOS	
			v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h/ln
S	*49.5*	mph	S	mph
D = v_p / S	*45.9*	pc/mi/ln	D = v_p / S	pc/mi/ln
LOS	*F*		Required Number of Lanes, N	

Glossary		Factor Location	
N - Number of lanes	S - Speed	E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
V - Hourly volume	D - Density	E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 11-18	TRD - Page 11-11
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 11-2, 11-3	
DDHV - Directional design hour volume			

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-526 WB*
Agency or Company	*Atkins*	From/To	*4180-Rhett to Rivers*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*PM Peak*	Analysis Year	*2018 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*3485*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*15*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.930*

Speed Inputs			Calc Speed Adj and FFS		
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f_{LW}		mph
Number of Lanes, N	*2*		f_{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	*55.0*	mph	FFS	*55.0*	mph
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures			Design (N)	
Operational (LOS)			Design (N)	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*2081*	pc/h/ln	Design LOS	
			v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h/ln
S	*53.1*	mph	S	mph
D = v_p / S	*39.2*	pc/mi/ln	D = v_p / S	pc/mi/ln
LOS	*E*		Required Number of Lanes, N	

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-526 WB
Agency or Company	Atkins	Junction	4190-WB Off to Rivers NB
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2018 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Freeway Number of Lanes, N: 2	☐ Yes ☐ On
☑ No ☐ Off	Ramp Number of Lanes, N: 1	☑ No ☐ Off
L_{up} = ft	Acceleration Lane Length, L_A	L_{down} = ft
V_u = veh/h	Deceleration Lane Length L_D: 725	V_D = veh/h
	Freeway Volume, V_F: 3787	
	Ramp Volume, V_R: 235	
	Freeway Free-Flow Speed, S_{FF}: 55.0	
	Ramp Free-Flow Speed, S_{FR}: 45.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	3787	0.90	Level	16	0	0.926	1.00	4544
Ramp	235	0.90	Level	6	0	0.971	1.00	269
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 1.000 using Equation (Exhibit 13-7)

V_{12} = 4544 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	4544	Exhibit 13-8	4500	Yes
$V_{FO} = V_F - V_R$	4275	Exhibit 13-8	4500	No
V_R	269	Exhibit 13-10	2100	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	4544	Exhibit 13-8	4400:All	Yes

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = 36.8 (pc/mi/ln)

LOS = F (Exhibit 13-2)

Speed Determination

D_s = 0.322 (Exhibit 13-12)

S_R= 50.8 mph (Exhibit 13-12)

S_0= N/A mph (Exhibit 13-12)

S = 50.8 mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-526 WB
Agency or Company	Atkins	Junction	4190-WB Off to Rivers NB
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2018 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp
☐ Yes ☐ On
☑ No ☐ Off
L_{up} = ft
V_u = veh/h

Freeway Number of Lanes, N	2
Ramp Number of Lanes, N	1
Acceleration Lane Length, L_A	
Deceleration Lane Length L_D	725
Freeway Volume, V_F	3485
Ramp Volume, V_R	175
Freeway Free-Flow Speed, S_{FF}	55.0
Ramp Free-Flow Speed, S_{FR}	45.0

Downstream Adj Ramp
☐ Yes ☐ On
☑ No ☐ Off
L_{down} = ft
V_D = veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	3485	0.90	Level	15	0	0.930	1.00	4163
Ramp	175	0.90	Level	6	0	0.971	1.00	200
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)
P_{FM} = using Equation (Exhibit 13-6)
V_{12} = pc/h
V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)
Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No
Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No
If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = (pc/mi/ln)
LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)
S_R= mph (Exhibit 13-11)
S_0= mph (Exhibit 13-11)
S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)
P_{FD} = 1.000 using Equation (Exhibit 13-7)
V_{12} = 4163 pc/h
V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)
Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No
Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No
If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	4163	Exhibit 13-8	4500	No
$V_{FO} = V_F - V_R$	3963	Exhibit 13-8	4500	No
V_R	200	Exhibit 13-10	2100	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	4163	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = 33.5 (pc/mi/ln)
LOS = D (Exhibit 13-2)

Speed Determination

D_s = 0.316 (Exhibit 13-12)
S_R= 50.9 mph (Exhibit 13-12)
S_0= N/A mph (Exhibit 13-12)
S = 50.9 mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-526 WB
Agency or Company	Atkins	Junction	4200-WB Off to Rivers SB
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2018 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Number of Lanes, N	2	Downstream Adj Ramp	
☐ Yes	☐ On	Acceleration Lane Length, L_A		☐ Yes	☐ On
☑ No	☐ Off	Deceleration Lane Length L_D	700	☑ No	☐ Off
L_{up} =	ft	Freeway Volume, V_F	3552	L_{down} =	ft
V_u =	veh/h	Ramp Volume, V_R	225	V_D =	veh/h
		Freeway Free-Flow Speed, S_{FF}	55.0		
		Ramp Free-Flow Speed, S_{FR}	25.0		

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	3552	0.90	Level	17	0	0.922	1.00	4282
Ramp	225	0.90	Level	6	0	0.971	1.00	258
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 1.000 using Equation (Exhibit 13-7)

V_{12} = 4282 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	4282	Exhibit 13-8	4500	No
$V_{FO} = V_F - V_R$	4024	Exhibit 13-8	4500	No
V_R	258	Exhibit 13-10	1900	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	4282	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = 34.8 (pc/mi/ln)

LOS = D (Exhibit 13-2)

Speed Determination

D_s = 0.581 (Exhibit 13-12)

S_R= 47.4 mph (Exhibit 13-12)

S_0= N/A mph (Exhibit 13-12)

S = 47.4 mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-526 WB
Agency or Company	Atkins	Junction	4200-WB Off to Rivers SB
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2018 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Freeway Number of Lanes, N	2	Downstream Adj Ramp	
☐ Yes	☐ On	Ramp Number of Lanes, N	1	☐ Yes	☐ On
☑ No	☐ Off	Acceleration Lane Length, L_A		☑ No	☐ Off
L_{up} =	ft	Deceleration Lane Length L_D	700	L_{down} =	ft
V_u =	veh/h	Freeway Volume, V_F	3310	V_D =	veh/h
		Ramp Volume, V_R	61		
		Freeway Free-Flow Speed, S_{FF}	55.0		
		Ramp Free-Flow Speed, S_{FR}	25.0		

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	3310	0.90	Level	15	0	0.930	1.00	3954
Ramp	61	0.90	Level	20	0	0.909	1.00	75
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 1.000 using Equation (Exhibit 13-7)

V_{12} = 3954 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	3954	Exhibit 13-8	4500	No
$V_{FO} = V_F - V_R$	3879	Exhibit 13-8	4500	No
V_R	75	Exhibit 13-10	1900	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	3954	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = 32.0 (pc/mi/ln)

LOS = D (Exhibit 13-2)

Speed Determination

D_s = 0.565 (Exhibit 13-12)

S_R= 47.7 mph (Exhibit 13-12)

S_0= N/A mph (Exhibit 13-12)

S = 47.7 mph (Exhibit 13-13)

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-526 WB*
Agency or Company	*Atkins*	From/To	*4205-RiversSB Off to Rivers On*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2018 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*3327*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*17*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.922*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*55.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*55.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*2005*	pc/h/ln
S	*54.0*	mph
D = v_p / S	*37.2*	pc/mi/ln
LOS	*E*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-526 WB*
Agency or Company	*Atkins*	From/To	*4205-RiversSB Off to Rivers On*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*PM Peak*	Analysis Year	*2018 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*3249*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*15*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.930*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*55.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*55.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1940*	pc/h/ln
S	*54.5*	mph
D = v_p / S	*35.6*	pc/mi/ln
LOS	*E*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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Navy Base ICTF

FREEWAY WEAVING WORKSHEET

General Information

Analyst	AJR
Agency/Company	Atkins
Date Performed	7/25/2014
Analysis Time Period	AM Peak

Site Information

Freeway/Dir of Travel	I-526 WB
Weaving Segment Location	4210 - Rivers to I-26 WB
Analysis Year	2018 No Action

Project Description *Navy Base ICTF*

Inputs

Weaving configuration	One-Sided	Segment type	Freeway
Weaving number of lanes, N	3	Freeway minimum speed, S_{MIN}	15
Weaving segment length, L_S	725ft	Freeway maximum capacity, C_{IFL}	2250
Freeway free-flow speed, FFS	55 mph	Terrain type	Level

Conversions to pc/h Under Base Conditions

	V (veh/h)	PHF	Truck (%)	RV (%)	E_T	E_R	f_{HV}	f_p	v (pc/h)
V_{FF}	2185	0.90	17	0	1.5	1.2	0.922	1.00	2634
V_{RF}	364	0.90	17	0	1.5	1.2	0.922	1.00	439
V_{FR}	1142	0.90	54	0	1.5	1.2	0.787	1.00	1611
V_{RR}	191	0.90	54	0	1.5	1.2	0.787	1.00	270
V_{NW}	2904							V =	4954
V_W	2050								
VR	0.414								

Configuration Characteristics

Minimum maneuver lanes, N_{WL}	2 lc	Minimum weaving lane changes, LC_{MIN}	2050 lc/h
Interchange density, ID	1.2 int/mi	Weaving lane changes, LC_W	2186 lc/h
Minimum RF lane changes, LC_{RF}	1 lc/pc	Non-weaving lane changes, LC_{NW}	413 lc/h
Minimum FR lane changes, LC_{FR}	1 lc/pc	Total lane changes, LC_{ALL}	2599 lc/h
Minimum RR lane changes, LC_{RR}	lc/pc	Non-weaving vehicle index, I_{NW}	253

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment flow rate, v	4954 pc/h	Weaving intensity factor, W	0.619
Weaving segment capacity, c_w	4927 veh/h	Weaving segment speed, S	35.0 mph
Weaving segment v/c ratio	0.927	Average weaving speed, S_W	39.7 mph
Weaving segment density, D	47.2 pc/mi/ln	Average non-weaving speed, S_{NW}	32.3 mph
Level of Service, LOS	E	Maximum weaving length, L_{MAX}	6836 ft

Notes

a. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments".
b. For volumes that exceed the weaving segment capacity, the level of service is "F".

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Navy Base ICTF

FREEWAY WEAVING WORKSHEET

General Information

Analyst	AJR
Agency/Company	Atkins
Date Performed	7/25/2014
Analysis Time Period	PM Peak

Site Information

Freeway/Dir of Travel	I-526 WB
Weaving Segment Location	4210 - Rivers to I-26 WB
Analysis Year	2018 No Action

Project Description *Navy Base ICTF*

Inputs

Weaving configuration	One-Sided	Segment type	Freeway
Weaving number of lanes, N	3	Freeway minimum speed, S_{MIN}	15
Weaving segment length, L_S	725ft	Freeway maximum capacity, C_{IFL}	2250
Freeway free-flow speed, FFS	55 mph	Terrain type	Level

Conversions to pc/h Under Base Conditions

	V (veh/h)	PHF	Truck (%)	RV (%)	E_T	E_R	f_{HV}	f_p	v (pc/h)
V_{FF}	1860	0.90	15	0	1.5	1.2	0.930	1.00	2222
V_{RF}	288	0.90	15	0	1.5	1.2	0.930	1.00	344
V_{FR}	1389	0.90	39	0	1.5	1.2	0.837	1.00	1844
V_{RR}	216	0.90	39	0	1.5	1.2	0.837	1.00	287
V_{NW}	2509							V =	4697
V_W	2188								
VR	0.466								

Configuration Characteristics

Minimum maneuver lanes, N_{WL}	2 lc	Minimum weaving lane changes, LC_{MIN}	2188 lc/h
Interchange density, ID	1.2 int/mi	Weaving lane changes, LC_W	2324 lc/h
Minimum RF lane changes, LC_{RF}	1 lc/pc	Non-weaving lane changes, LC_{NW}	332 lc/h
Minimum FR lane changes, LC_{FR}	1 lc/pc	Total lane changes, LC_{ALL}	2656 lc/h
Minimum RR lane changes, LC_{RR}	lc/pc	Non-weaving vehicle index, I_{NW}	218

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment flow rate, v	4697 pc/h	Weaving intensity factor, W	0.630
Weaving segment capacity, c_w	4793 veh/h	Weaving segment speed, S	34.9 mph
Weaving segment v/c ratio	0.912	Average weaving speed, S_W	39.5 mph
Weaving segment density, D	44.8 pc/mi/ln	Average non-weaving speed, S_{NW}	31.7 mph
Level of Service, LOS	E	Maximum weaving length, L_{MAX}	7430 ft

Notes

a. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments".
b. For volumes that exceed the weaving segment capacity, the level of service is "F".

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-526 WB*
Agency or Company	*Atkins*	From/To	*4215-I-26 WB Off to I-26 WB On*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2018 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*2549*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*17*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.922*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*55.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*55.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1536*	pc/h/ln
S	*55.0*	mph
D = v_p / S	*27.9*	pc/mi/ln
LOS	*D*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-526 WB*
Agency or Company	*Atkins*	From/To	*4215-I-26 WB Off to I-26 WB On*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*PM Peak*	Analysis Year	*2018 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*2148*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*15*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.930*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*55.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*55.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1283*	pc/h/ln
S	*55.0*	mph
D = v_p / S	*23.3*	pc/mi/ln
LOS	*C*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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Navy Base ICTF

FREEWAY WEAVING WORKSHEET

General Information

Analyst	AJR
Agency/Company	Atkins
Date Performed	7/25/2014
Analysis Time Period	AM Peak

Site Information

Freeway/Dir of Travel	I-526 WB
Weaving Segment Location	4220 - I-26 WB to I-26 EB C-D
Analysis Year	2018 No Action

Project Description *Navy Base ICTF*

Inputs

Weaving configuration	One-Sided	Segment type	Freeway
Weaving number of lanes, N	3	Freeway minimum speed, S_{MIN}	15
Weaving segment length, L_S	550ft	Freeway maximum capacity, C_{IFL}	2250
Freeway free-flow speed, FFS	55 mph	Terrain type	Level

Conversions to pc/h Under Base Conditions

	V (veh/h)	PHF	Truck (%)	RV (%)	E_T	E_R	f_{HV}	f_p	v (pc/h)
V_{FF}	2011	0.90	17	0	1.5	1.2	0.922	1.00	2424
V_{RF}	275	0.90	7	0	1.5	1.2	0.966	1.00	316
V_{FR}	538	0.90	8	0	1.5	1.2	0.962	1.00	622
V_{RR}	0	0.90	0	0	1.5	1.2	1.000	1.00	0
V_{NW}	2424							V =	3362
V_W	938								
VR	0.279								

Configuration Characteristics

Minimum maneuver lanes, N_{WL}	2 lc	Minimum weaving lane changes, LC_{MIN}	938 lc/h
Interchange density, ID	1.2 int/mi	Weaving lane changes, LC_W	1042 lc/h
Minimum RF lane changes, LC_{RF}	1 lc/pc	Non-weaving lane changes, LC_{NW}	220 lc/h
Minimum FR lane changes, LC_{FR}	1 lc/pc	Total lane changes, LC_{ALL}	1262 lc/h
Minimum RR lane changes, LC_{RR}	lc/pc	Non-weaving vehicle index, I_{NW}	160

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment flow rate, v	3362 pc/h	Weaving intensity factor, W	0.435
Weaving segment capacity, c_w	5204 veh/h	Weaving segment speed, S	42.9 mph
Weaving segment v/c ratio	0.595	Average weaving speed, S_W	42.9 mph
Weaving segment density, D	26.1 pc/mi/ln	Average non-weaving speed, S_{NW}	42.9 mph
Level of Service, LOS	C	Maximum weaving length, L_{MAX}	5360 ft

Notes

a. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments".
b. For volumes that exceed the weaving segment capacity, the level of service is "F".

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Navy Base ICTF

FREEWAY WEAVING WORKSHEET

General Information

Analyst	AJR
Agency/Company	Atkins
Date Performed	7/25/2014
Analysis Time Period	PM Peak

Site Information

Freeway/Dir of Travel	I-526 WB
Weaving Segment Location	4220 - I-26 WB to I-26 EB C-D
Analysis Year	2018 No Action

Project Description *Navy Base ICTF*

Inputs

Weaving configuration	One-Sided	Segment type	Freeway
Weaving number of lanes, N	3	Freeway minimum speed, S_{MIN}	15
Weaving segment length, L_S	550ft	Freeway maximum capacity, C_{IFL}	2250
Freeway free-flow speed, FFS	55 mph	Terrain type	Level

Conversions to pc/h Under Base Conditions

	V (veh/h)	PHF	Truck (%)	RV (%)	E_T	E_R	f_{HV}	f_p	v (pc/h)
V_{FF}	1674	0.90	15	0	1.5	1.2	0.930	1.00	2000
V_{RF}	338	0.90	5	0	1.5	1.2	0.976	1.00	385
V_{FR}	474	0.90	8	0	1.5	1.2	0.962	1.00	548
V_{RR}	0	0.90	0	0	1.5	1.2	1.000	1.00	0
V_{NW}	2000							V =	2933
V_W	933								
VR	0.318								

Configuration Characteristics

Minimum maneuver lanes, N_{WL}	2 lc	Minimum weaving lane changes, LC_{MIN}	933 lc/h
Interchange density, ID	1.2 int/mi	Weaving lane changes, LC_W	1037 lc/h
Minimum RF lane changes, LC_{RF}	1 lc/pc	Non-weaving lane changes, LC_{NW}	132 lc/h
Minimum FR lane changes, LC_{FR}	1 lc/pc	Total lane changes, LC_{ALL}	1169 lc/h
Minimum RR lane changes, LC_{RR}	lc/pc	Non-weaving vehicle index, I_{NW}	132

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment flow rate, v	2933 pc/h	Weaving intensity factor, W	0.410
Weaving segment capacity, c_w	5163 veh/h	Weaving segment speed, S	43.5 mph
Weaving segment v/c ratio	0.528	Average weaving speed, S_W	43.4 mph
Weaving segment density, D	22.5 pc/mi/ln	Average non-weaving speed, S_{NW}	43.6 mph
Level of Service, LOS	C	Maximum weaving length, L_{MAX}	5779 ft

Notes

a. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments".
b. For volumes that exceed the weaving segment capacity, the level of service is "F".

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-526 WB*
Agency or Company	*Atkins*	From/To	*4225-I-26 EB CD Off to On*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2018 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*2286*	veh/h	Peak-Hour Factor, PHF	*0.90*	
AADT		veh/day	%Trucks and Buses, P_T	*17*	
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*	
Peak-Hr Direction Prop, D			General Terrain:	*Level*	
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*	

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.922*

Speed Inputs			Calc Speed Adj and FFS		
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f_{LW}		mph
Number of Lanes, N	*2*		f_{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	*55.0*	mph	FFS	*55.0*	mph
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures			Design (N)	
Operational (LOS)			Design (N)	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1378*	pc/h/ln	Design LOS	
			v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h/ln
S	*55.0*	mph	S	mph
D = v_p / S	*25.1*	pc/mi/ln	D = v_p / S	pc/mi/ln
LOS	*C*		Required Number of Lanes, N	

Glossary		Factor Location	
N - Number of lanes	S - Speed	E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
V - Hourly volume	D - Density	E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 11-18	TRD - Page 11-11
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 11-2, 11-3	
DDHV - Directional design hour volume			

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-526 WB*
Agency or Company	*Atkins*	From/To	*4225-I-26 EB CD Off to On*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*PM Peak*	Analysis Year	*2018 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*2012*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*15*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.930*

Speed Inputs			Calc Speed Adj and FFS		
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f_{LW}		mph
Number of Lanes, N	*2*		f_{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	*55.0*	mph	FFS	*55.0*	mph
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures			Design (N)	
Operational (LOS)			Design (N)	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1202*	pc/h/ln	Design LOS	
			v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h/ln
S	*55.0*	mph	S	mph
D = v_p / S	*21.9*	pc/mi/ln	D = v_p / S	pc/mi/ln
LOS	*C*		Required Number of Lanes, N	

Glossary		Factor Location	
N - Number of lanes	S - Speed	E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
V - Hourly volume	D - Density	E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 11-18	TRD - Page 11-11
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 11-2, 11-3	
DDHV - Directional design hour volume			

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Navy Base ICTF

FREEWAY WEAVING WORKSHEET

General Information

Analyst	AJR
Agency/Company	Atkins
Date Performed	7/25/2014
Analysis Time Period	AM Peak

Site Information

Freeway/Dir of Travel	I-526 WB
Weaving Segment Location	4230-I-26EBCD to International
Analysis Year	2018 No Action

Project Description *Navy Base ICTF*

Inputs

Weaving configuration	One-Sided	Segment type	Freeway
Weaving number of lanes, N	3	Freeway minimum speed, S_{MIN}	15
Weaving segment length, L_S	3135ft	Freeway maximum capacity, C_{IFL}	2300
Freeway free-flow speed, FFS	60 mph	Terrain type	Level

Conversions to pc/h Under Base Conditions

	V (veh/h)	PHF	Truck (%)	RV (%)	E_T	E_R	f_{HV}	f_p	v (pc/h)
V_{FF}	1535	0.90	10	0	1.5	1.2	0.952	1.00	1791
V_{RF}	1491	0.90	20	0	1.5	1.2	0.909	1.00	1822
V_{FR}	751	0.90	13	0	1.5	1.2	0.939	1.00	889
V_{RR}	730	0.90	20	0	1.5	1.2	0.909	1.00	892
V_{NW}	2683							V =	5394
V_W	2711								
VR	0.503								

Configuration Characteristics

Minimum maneuver lanes, N_{WL}	2 lc	Minimum weaving lane changes, LC_{MIN}	lc/h
Interchange density, ID	1.0 int/mi	Weaving lane changes, LC_W	lc/h
Minimum RF lane changes, LC_{RF}	1 lc/pc	Non-weaving lane changes, LC_{NW}	lc/h
Minimum FR lane changes, LC_{FR}	1 lc/pc	Total lane changes, LC_{ALL}	lc/h
Minimum RR lane changes, LC_{RR}	lc/pc	Non-weaving vehicle index, I_{NW}	561

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment flow rate, v	5394 pc/h	Weaving intensity factor, W	
Weaving segment capacity, c_w	4548 veh/h	Weaving segment speed, S	mph
Weaving segment v/c ratio	1.130	Average weaving speed, S_W	mph
Weaving segment density, D	pc/mi/ln	Average non-weaving speed, S_{NW}	mph
Level of Service, LOS	F	Maximum weaving length, L_{MAX}	7857 ft

Notes

a. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments".
b. For volumes that exceed the weaving segment capacity, the level of service is "F".

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Navy Base ICTF

FREEWAY WEAVING WORKSHEET

General Information

Analyst	AJR
Agency/Company	Atkins
Date Performed	7/25/2014
Analysis Time Period	PM Peak

Site Information

Freeway/Dir of Travel	I-526 WB
Weaving Segment Location	4230-I-26EBCD to International
Analysis Year	2018 No Action

Project Description *Navy Base ICTF*

Inputs

Weaving configuration	One-Sided	Segment type	Freeway
Weaving number of lanes, N	3	Freeway minimum speed, S_{MIN}	15
Weaving segment length, L_S	3135ft	Freeway maximum capacity, C_{IFL}	2300
Freeway free-flow speed, FFS	60 mph	Terrain type	Level

Conversions to pc/h Under Base Conditions

	V (veh/h)	PHF	Truck (%)	RV (%)	E_T	E_R	f_{HV}	f_p	v (pc/h)
V_{FF}	1119	0.90	8	0	1.5	1.2	0.962	1.00	1293
V_{RF}	991	0.90	21	0	1.5	1.2	0.905	1.00	1217
V_{FR}	893	0.90	9	0	1.5	1.2	0.957	1.00	1037
V_{RR}	790	0.90	21	0	1.5	1.2	0.905	1.00	970
V_{NW}	2263							V =	4517
V_W	2254								
VR	0.499								

Configuration Characteristics

Minimum maneuver lanes, N_{WL}	2 lc	Minimum weaving lane changes, LC_{MIN}	2254 lc/h
Interchange density, ID	1.0 int/mi	Weaving lane changes, LC_W	2579 lc/h
Minimum RF lane changes, LC_{RF}	1 lc/pc	Non-weaving lane changes, LC_{NW}	1588 lc/h
Minimum FR lane changes, LC_{FR}	1 lc/pc	Total lane changes, LC_{ALL}	4167 lc/h
Minimum RR lane changes, LC_{RR}	lc/pc	Non-weaving vehicle index, I_{NW}	709

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment flow rate, v	4517 pc/h	Weaving intensity factor, W	0.283
Weaving segment capacity, c_w	4625 veh/h	Weaving segment speed, S	42.2 mph
Weaving segment v/c ratio	0.939	Average weaving speed, S_W	50.1 mph
Weaving segment density, D	35.6 pc/mi/ln	Average non-weaving speed, S_{NW}	36.5 mph
Level of Service, LOS	E	Maximum weaving length, L_{MAX}	7815 ft

Notes

a. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments".
b. For volumes that exceed the weaving segment capacity, the level of service is "F".

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-526 WB*
Agency or Company	*Atkins*	From/To	*4235-Interna Off to Interna On*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2018 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*3026*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*10*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.952*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*60.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*60.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1765*	pc/h/ln
S	*59.5*	mph
D = v_p / S	*29.7*	pc/mi/ln
LOS	*D*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-526 WB*
Agency or Company	*Atkins*	From/To	*4235-Interna Off to Interna On*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*PM Peak*	Analysis Year	*2018 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*2110*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*9*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.957*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*60.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*60.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1225*	pc/h/ln
S	*60.0*	mph
D = v_p / S	*20.4*	pc/mi/ln
LOS	*C*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-526 WB
Agency or Company	Atkins	Junction	4240-WB On from International
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2018 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Freeway Number of Lanes, N: 2	☐ Yes ☐ On
☑ No ☐ Off	Ramp Number of Lanes, N: 1	☑ No ☐ Off
L_{up} = ft	Acceleration Lane Length, L_A: 875	L_{down} = ft
V_u = veh/h	Deceleration Lane Length L_D:	V_D = veh/h
	Freeway Volume, V_F: 3026	
	Ramp Volume, V_R: 405	
	Freeway Free-Flow Speed, S_{FF}: 60.0	
	Ramp Free-Flow Speed, S_{FR}: 45.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	3026	0.90	Level	10	0	0.952	1.00	3530
Ramp	405	0.90	Level	21	0	0.905	1.00	497
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 1.000 using Equation (Exhibit 13-6)

V_{12} = 3530 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	4027	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	4027	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = 31.2 (pc/mi/ln)

LOS = D (Exhibit 13-2)

Speed Determination

M_S = 0.461 (Exibit 13-11)

S_R= 51.7 mph (Exhibit 13-11)

S_0= N/A mph (Exhibit 13-11)

S = 51.7 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-526 WB
Agency or Company	Atkins	Junction	4240-WB On from International
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2018 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Freeway Number of Lanes, N: 2	☐ Yes ☐ On
☑ No ☐ Off	Ramp Number of Lanes, N: 1	☑ No ☐ Off
L_{up} = ft	Acceleration Lane Length, L_A: 875	L_{down} = ft
V_u = veh/h	Deceleration Lane Length L_D:	V_D = veh/h
	Freeway Volume, V_F: 2110	
	Ramp Volume, V_R: 605	
	Freeway Free-Flow Speed, S_{FF}: 60.0	
	Ramp Free-Flow Speed, S_{FR}: 45.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	2110	0.90	Level	9	0	0.957	1.00	2450
Ramp	605	0.90	Level	12	0	0.943	1.00	713
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 1.000 using Equation (Exhibit 13-6)

V_{12} = 2450 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	3163	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	3163	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = 24.3 (pc/mi/ln)

LOS = C (Exhibit 13-2)

Speed Determination

M_S = 0.334 (Exibit 13-11)

S_R= 54.0 mph (Exhibit 13-11)

S_0= N/A mph (Exhibit 13-11)

S = 54.0 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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Navy Base ICTF

FREEWAY WEAVING WORKSHEET

General Information

Analyst	AJR
Agency/Company	Atkins
Date Performed	7/25/2014
Analysis Time Period	AM Peak

Site Information

Freeway/Dir of Travel	I-526 WB
Weaving Segment Location	4250-Montague to Dorchester
Analysis Year	2018 No Action

Project Description *Navy Base ICTF*

Inputs

Weaving configuration	One-Sided	Segment type	Freeway
Weaving number of lanes, N	3	Freeway minimum speed, S_{MIN}	15
Weaving segment length, L_S	950ft	Freeway maximum capacity, C_{IFL}	2300
Freeway free-flow speed, FFS	60 mph	Terrain type	Level

Conversions to pc/h Under Base Conditions

	V (veh/h)	PHF	Truck (%)	RV (%)	E_T	E_R	f_{HV}	f_p	v (pc/h)
V_{FF}	2727	0.90	9	0	1.5	1.2	0.957	1.00	3166
V_{RF}	449	0.90	9	0	1.5	1.2	0.957	1.00	521
V_{FR}	704	0.90	15	0	1.5	1.2	0.930	1.00	841
V_{RR}	116	0.90	15	0	1.5	1.2	0.930	1.00	139
V_{NW}	3305							V =	4667
V_W	1362								
VR	0.292								

Configuration Characteristics

Minimum maneuver lanes, N_{WL}	2 lc	Minimum weaving lane changes, LC_{MIN}	1362 lc/h
Interchange density, ID	1.0 int/mi	Weaving lane changes, LC_W	1518 lc/h
Minimum RF lane changes, LC_{RF}	1 lc/pc	Non-weaving lane changes, LC_{NW}	618 lc/h
Minimum FR lane changes, LC_{FR}	1 lc/pc	Total lane changes, LC_{ALL}	2136 lc/h
Minimum RR lane changes, LC_{RR}	lc/pc	Non-weaving vehicle index, I_{NW}	314

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment flow rate, v	4667 pc/h	Weaving intensity factor, W	0.428
Weaving segment capacity, c_w	5604 veh/h	Weaving segment speed, S	43.8 mph
Weaving segment v/c ratio	0.797	Average weaving speed, S_W	46.5 mph
Weaving segment density, D	35.5 pc/mi/ln	Average non-weaving speed, S_{NW}	42.7 mph
Level of Service, LOS	E	Maximum weaving length, L_{MAX}	5496 ft

Notes

a. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments".
b. For volumes that exceed the weaving segment capacity, the level of service is "F".

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Navy Base ICTF

FREEWAY WEAVING WORKSHEET

General Information

Analyst	AJR
Agency/Company	Atkins
Date Performed	7/25/2014
Analysis Time Period	PM Peak

Site Information

Freeway/Dir of Travel	I-526 WB
Weaving Segment Location	4250-Montague to Dorchester
Analysis Year	2018 No Action

Project Description *Navy Base ICTF*

Inputs

Weaving configuration	One-Sided	Segment type	Freeway
Weaving number of lanes, N	3	Freeway minimum speed, S_{MIN}	15
Weaving segment length, L_S	950ft	Freeway maximum capacity, C_{IFL}	2300
Freeway free-flow speed, FFS	60 mph	Terrain type	Level

Conversions to pc/h Under Base Conditions

	V (veh/h)	PHF	Truck (%)	RV (%)	E_T	E_R	f_{HV}	f_p	v (pc/h)
V_{FF}	2216	0.90	8	0	1.5	1.2	0.962	1.00	2561
V_{RF}	624	0.90	8	0	1.5	1.2	0.962	1.00	721
V_{FR}	499	0.90	16	0	1.5	1.2	0.926	1.00	599
V_{RR}	140	0.90	16	0	1.5	1.2	0.926	1.00	168
V_{NW}	2729							V =	4049
V_W	1320								
VR	0.326								

Configuration Characteristics

Minimum maneuver lanes, N_{WL}	2 lc	Minimum weaving lane changes, LC_{MIN}	1320 lc/h
Interchange density, ID	1.0 int/mi	Weaving lane changes, LC_W	1476 lc/h
Minimum RF lane changes, LC_{RF}	1 lc/pc	Non-weaving lane changes, LC_{NW}	499 lc/h
Minimum FR lane changes, LC_{FR}	1 lc/pc	Total lane changes, LC_{ALL}	1975 lc/h
Minimum RR lane changes, LC_{RR}	lc/pc	Non-weaving vehicle index, I_{NW}	259

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment flow rate, v	4049 pc/h	Weaving intensity factor, W	0.403
Weaving segment capacity, c_w	5550 veh/h	Weaving segment speed, S	45.0 mph
Weaving segment v/c ratio	0.701	Average weaving speed, S_W	47.1 mph
Weaving segment density, D	30.0 pc/mi/ln	Average non-weaving speed, S_{NW}	44.0 mph
Level of Service, LOS	D	Maximum weaving length, L_{MAX}	5865 ft

Notes

a. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments".
b. For volumes that exceed the weaving segment capacity, the level of service is "F".

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-526 WB*
Agency or Company	*Atkins*	From/To	*4255-Dorches Off to Dorches On*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2018 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*3176*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*9*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.957*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*60.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*60.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1844*	pc/h/ln
S	*58.9*	mph
D = v_p / S	*31.3*	pc/mi/ln
LOS	*D*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-526 WB*
Agency or Company	*Atkins*	From/To	*4255-Dorches Off to Dorches On*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*PM Peak*	Analysis Year	*2018 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*2840*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*8*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.962*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*60.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*60.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1641*	pc/h/ln
S	*60.0*	mph
D = v_p / S	*27.4*	pc/mi/ln
LOS	*D*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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Navy Base ICTF

FREEWAY WEAVING WORKSHEET

General Information

Analyst	AJR
Agency/Company	Atkins
Date Performed	7/25/2014
Analysis Time Period	AM Peak

Site Information

Freeway/Dir of Travel	I-526 WB
Weaving Segment Location	4260-Dorchester to Leeds
Analysis Year	2018 No Action

Project Description *Navy Base ICTF*

Inputs

Weaving configuration	One-Sided	Segment type	Freeway
Weaving number of lanes, N	3	Freeway minimum speed, S_{MIN}	15
Weaving segment length, L_S	1750ft	Freeway maximum capacity, C_{IFL}	2300
Freeway free-flow speed, FFS	60 mph	Terrain type	Level

Conversions to pc/h Under Base Conditions

	V (veh/h)	PHF	Truck (%)	RV (%)	E_T	E_R	f_{HV}	f_p	v (pc/h)
V_{FF}	2327	0.90	8	0	1.5	1.2	0.962	1.00	2689
V_{RF}	461	0.90	17	0	1.5	1.2	0.922	1.00	556
V_{FR}	849	0.90	17	0	1.5	1.2	0.922	1.00	1024
V_{RR}	169	0.90	17	0	1.5	1.2	0.922	1.00	204
V_{NW}	2893							V =	4473
V_W	1580								
VR	0.353								

Configuration Characteristics

Minimum maneuver lanes, N_{WL}	2 lc	Minimum weaving lane changes, LC_{MIN}	1580 lc/h
Interchange density, ID	1.0 int/mi	Weaving lane changes, LC_W	1813 lc/h
Minimum RF lane changes, LC_{RF}	1 lc/pc	Non-weaving lane changes, LC_{NW}	967 lc/h
Minimum FR lane changes, LC_{FR}	1 lc/pc	Total lane changes, LC_{ALL}	2780 lc/h
Minimum RR lane changes, LC_{RR}	lc/pc	Non-weaving vehicle index, I_{NW}	506

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment flow rate, v	4473 pc/h	Weaving intensity factor, W	0.326
Weaving segment capacity, c_w	5660 veh/h	Weaving segment speed, S	43.8 mph
Weaving segment v/c ratio	0.760	Average weaving speed, S_W	48.9 mph
Weaving segment density, D	34.0 pc/mi/ln	Average non-weaving speed, S_{NW}	41.5 mph
Level of Service, LOS	D	Maximum weaving length, L_{MAX}	6162 ft

Notes

a. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments".
b. For volumes that exceed the weaving segment capacity, the level of service is "F".

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Navy Base ICTF

FREEWAY WEAVING WORKSHEET

General Information

Analyst	AJR
Agency/Company	Atkins
Date Performed	7/25/2014
Analysis Time Period	PM Peak

Site Information

Freeway/Dir of Travel	I-526 WB
Weaving Segment Location	4260-Dorchester to Leeds
Analysis Year	2018 No Action

Project Description *Navy Base ICTF*

Inputs

Weaving configuration	One-Sided	Segment type	Freeway
Weaving number of lanes, N	3	Freeway minimum speed, S_{MIN}	15
Weaving segment length, L_S	1750ft	Freeway maximum capacity, C_{IFL}	2300
Freeway free-flow speed, FFS	60 mph	Terrain type	Level

Conversions to pc/h Under Base Conditions

	V (veh/h)	PHF	Truck (%)	RV (%)	E_T	E_R	f_{HV}	f_p	v (pc/h)
V_{FF}	2576	0.90	7	0	1.5	1.2	0.966	1.00	2962
V_{RF}	485	0.90	17	0	1.5	1.2	0.922	1.00	585
V_{FR}	264	0.90	15	0	1.5	1.2	0.930	1.00	315
V_{RR}	50	0.90	17	0	1.5	1.2	0.922	1.00	60
V_{NW}	3022							V =	3922
V_W	900								
VR	0.229								

Configuration Characteristics

Minimum maneuver lanes, N_{WL}	2 lc	Minimum weaving lane changes, LC_{MIN}	900 lc/h
Interchange density, ID	1.0 int/mi	Weaving lane changes, LC_W	1133 lc/h
Minimum RF lane changes, LC_{RF}	1 lc/pc	Non-weaving lane changes, LC_{NW}	993 lc/h
Minimum FR lane changes, LC_{FR}	1 lc/pc	Total lane changes, LC_{ALL}	2126 lc/h
Minimum RR lane changes, LC_{RR}	lc/pc	Non-weaving vehicle index, I_{NW}	529

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment flow rate, v	3922 pc/h	Weaving intensity factor, W	0.264
Weaving segment capacity, c_w	5983 veh/h	Weaving segment speed, S	48.0 mph
Weaving segment v/c ratio	0.633	Average weaving speed, S_W	50.6 mph
Weaving segment density, D	27.2 pc/mi/ln	Average non-weaving speed, S_{NW}	47.2 mph
Level of Service, LOS	C	Maximum weaving length, L_{MAX}	4840 ft

Notes

a. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments".
b. For volumes that exceed the weaving segment capacity, the level of service is "F".

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-526 WB*
Agency or Company	*Atkins*	From/To	*4265-Leeds Off to Leeds On*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2018 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*2788*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*10*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.952*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*60.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*60.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1626*	pc/h/ln
S	*60.0*	mph
D = v_p / S	*27.1*	pc/mi/ln
LOS	*D*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-526 WB*
Agency or Company	*Atkins*	From/To	*4265-Leeds Off to Leeds On*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*PM Peak*	Analysis Year	*2018 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*3061*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*8*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.962*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*60.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*60.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1769*	pc/h/ln
S	*59.5*	mph
D = v_p / S	*29.7*	pc/mi/ln
LOS	*D*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-526 WB
Agency or Company	Atkins	Junction	4270-WB On from Leeds
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2018 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Number of Lanes, N: 2	☐ Yes ☐ On
☑ No ☐ Off	Acceleration Lane Length, L_A: 825	☑ No ☐ Off
L_{up} = ft	Deceleration Lane Length L_D:	L_{down} = ft
V_u = veh/h	Freeway Volume, V_F: 2788	V_D = veh/h
	Ramp Volume, V_R: 222	
	Freeway Free-Flow Speed, S_{FF}: 60.0	
	Ramp Free-Flow Speed, S_{FR}: 45.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	2788	0.90	Level	10	0	0.952	1.00	3253
Ramp	222	0.90	Level	19	0	0.913	1.00	270
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 1.000 using Equation (Exhibit 13-6)

V_{12} = 3253 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	3523	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	3523	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = 27.7 (pc/mi/ln)

LOS = C (Exhibit 13-2)

Speed Determination

M_S = 0.379 (Exibit 13-11)

S_R= 53.2 mph (Exhibit 13-11)

S_0= N/A mph (Exhibit 13-11)

S = 53.2 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-526 WB
Agency or Company	Atkins	Junction	4270-WB On from Leeds
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2018 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Number of Lanes, N: 2	☐ Yes ☐ On
☑ No ☐ Off	Acceleration Lane Length, L_A: 825	☑ No ☐ Off
L_{up} = ft	Deceleration Lane Length L_D:	L_{down} = ft
V_u = veh/h	Freeway Volume, V_F: 3061	V_D = veh/h
	Ramp Volume, V_R: 696	
	Freeway Free-Flow Speed, S_{FF}: 60.0	
	Ramp Free-Flow Speed, S_{FR}: 45.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	3061	0.90	Level	8	0	0.962	1.00	3537
Ramp	696	0.90	Level	5	0	0.976	1.00	793
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 1.000 using Equation (Exhibit 13-6)

V_{12} = 3537 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	4330	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	4330	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = 33.7 (pc/mi/ln)

LOS = D (Exhibit 13-2)

Speed Determination

M_S = 0.543 (Exibit 13-11)

S_R= 50.2 mph (Exhibit 13-11)

S_0= N/A mph (Exhibit 13-11)

S = 50.2 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-526 WB*
Agency or Company	*Atkins*	From/To	*4280-Leeds to Paul Cantrell*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2018 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*3010*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*10*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.952*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*60.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*60.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1756*	pc/h/ln
S	*59.6*	mph
D = v_p / S	*29.5*	pc/mi/ln
LOS	*D*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-526 WB*
Agency or Company	*Atkins*	From/To	*4280-Leeds to Paul Cantrell*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*PM Peak*	Analysis Year	*2018 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*3757*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*8*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.962*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*60.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*60.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*2171*	pc/h/ln
S	*54.1*	mph
D = v_p / S	*40.1*	pc/mi/ln
LOS	*E*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-526 WB
Agency or Company	Atkins	Junction	4290-WB Off to PaulCantrell WB
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2018 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Freeway Number of Lanes, N	2	Downstream Adj Ramp	
☐ Yes	☐ On	Ramp Number of Lanes, N	1	☐ Yes	☐ On
☑ No	☐ Off	Acceleration Lane Length, L_A		☑ No	☐ Off
L_{up} =	ft	Deceleration Lane Length L_D	825	L_{down} =	ft
V_u =	veh/h	Freeway Volume, V_F	3010	V_D =	veh/h
		Ramp Volume, V_R	1258		
		Freeway Free-Flow Speed, S_{FF}	60.0		
		Ramp Free-Flow Speed, S_{FR}	45.0		

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	3010	0.90	Level	10	0	0.952	1.00	3512
Ramp	1258	0.90	Level	27	0	0.881	1.00	1586
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 1.000 using Equation (Exhibit 13-7)

V_{12} = 3512 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	3512	Exhibit 13-8	4600	No
$V_{FO} = V_F - V_R$	1926	Exhibit 13-8	4600	No
V_R	1586	Exhibit 13-10	2100	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	3512	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = 27.0 (pc/mi/ln)

LOS = C (Exhibit 13-2)

Speed Determination

D_s = 0.441 (Exhibit 13-12)

S_R= 52.1 mph (Exhibit 13-12)

S_0= N/A mph (Exhibit 13-12)

S = 52.1 mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-526 WB
Agency or Company	Atkins	Junction	4290-WB Off to PaulCantrell WB
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2018 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Freeway Number of Lanes, N	2	Downstream Adj Ramp	
☐ Yes	☐ On	Ramp Number of Lanes, N	1	☐ Yes	☐ On
☑ No	☐ Off	Acceleration Lane Length, L_A		☑ No	☐ Off
L_{up} =	ft	Deceleration Lane Length L_D	825	L_{down} =	ft
V_u =	veh/h	Freeway Volume, V_F	3757	V_D =	veh/h
		Ramp Volume, V_R	2019		
		Freeway Free-Flow Speed, S_{FF}	60.0		
		Ramp Free-Flow Speed, S_{FR}	45.0		

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	3757	0.90	Level	8	0	0.962	1.00	4341
Ramp	2019	0.90	Level	15	0	0.930	1.00	2412
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 1.000 using Equation (Exhibit 13-7)

V_{12} = 4341 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	4341	Exhibit 13-8	4600	No
$V_{FO} = V_F - V_R$	1929	Exhibit 13-8	4600	No
V_R	2412	Exhibit 13-10	2100	Yes

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	4341	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = 34.2 (pc/mi/ln)

LOS = F (Exhibit 13-2)

Speed Determination

D_s = 0.515 (Exhibit 13-12)

S_R= 50.7 mph (Exhibit 13-12)

S_0= N/A mph (Exhibit 13-12)

S = 50.7 mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-526 WB
Agency or Company	Atkins	Junction	4300-WB Off to PaulCantrell EB
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2018 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Number of Lanes, N	2	Downstream Adj Ramp	
☐ Yes	☐ On	Acceleration Lane Length, L_A		☐ Yes	☐ On
☑ No	☐ Off	Deceleration Lane Length L_D	525	☑ No	☐ Off
L_{up} =	ft	Freeway Volume, V_F	1752	L_{down} =	ft
V_u =	veh/h	Ramp Volume, V_R	640	V_D =	veh/h
		Freeway Free-Flow Speed, S_{FF}	60.0		
		Ramp Free-Flow Speed, S_{FR}	25.0		

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	1752	0.90	Level	10	0	0.952	1.00	2044
Ramp	640	0.90	Level	5	0	0.976	1.00	729
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 1.000 using Equation (Exhibit 13-7)

V_{12} = 2044 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	2044	Exhibit 13-8	4600	No
$V_{FO} = V_F - V_R$	1315	Exhibit 13-8	4600	No
V_R	729	Exhibit 13-10	1900	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	2044	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = 17.1 (pc/mi/ln)

LOS = B (Exhibit 13-2)

Speed Determination

D_s = 0.624 (Exhibit 13-12)

S_R= 48.8 mph (Exhibit 13-12)

S_0= N/A mph (Exhibit 13-12)

S = 48.8 mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-526 WB
Agency or Company	Atkins	Junction	4300-WB Off to PaulCantrell EB
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2018 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Number of Lanes, N	2	Downstream Adj Ramp	
☐ Yes	☐ On	Acceleration Lane Length, L_A		☐ Yes	☐ On
☑ No	☐ Off	Deceleration Lane Length L_D	525	☑ No	☐ Off
L_{up} =	ft	Freeway Volume, V_F	1738	L_{down} =	ft
		Ramp Volume, V_R	681		
V_u =	veh/h	Freeway Free-Flow Speed, S_{FF}	60.0	V_D =	veh/h
		Ramp Free-Flow Speed, S_{FR}	25.0		

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	1738	0.90	Level	8	0	0.962	1.00	2008
Ramp	681	0.90	Level	4	0	0.980	1.00	772
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 1.000 using Equation (Exhibit 13-7)

V_{12} = 2008 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	2008	Exhibit 13-8	4600	No
$V_{FO} = V_F - V_R$	1236	Exhibit 13-8	4600	No
V_R	772	Exhibit 13-10	1900	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	2008	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = 16.8 (pc/mi/ln)

LOS = B (Exhibit 13-2)

Speed Determination

D_s = 0.627 (Exhibit 13-12)

S_R= 48.7 mph (Exhibit 13-12)

S_0= N/A mph (Exhibit 13-12)

S = 48.7 mph (Exhibit 13-13)

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-526 WB*
Agency or Company	*Atkins*	From/To	*4305-PaulCEB Off to PaulCEB On*
Date Performed	*4/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2018 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*1112*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*10*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.952*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*60.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*60.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*649*	pc/h/ln
S	*60.0*	mph
D = v_p / S	*10.8*	pc/mi/ln
LOS	*A*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-526 WB*
Agency or Company	*Atkins*	From/To	*4305-PaulCEB Off to PaulCEB On*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*PM Peak*	Analysis Year	*2018 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*1057*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*8*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.962*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*60.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*60.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*611*	pc/h/ln
S	*60.0*	mph
D = v_p / S	*10.2*	pc/mi/ln
LOS	*A*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-526 WB
Agency or Company	Atkins	Junction	4310-WB On from PaulCantrellEB
Date Performed	4/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2018 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Freeway Number of Lanes, N: 2	☐ Yes ☐ On
☑ No ☐ Off	Ramp Number of Lanes, N: 1	☑ No ☐ Off
L_{up} = ft	Acceleration Lane Length, L_A: 700	L_{down} = ft
V_u = veh/h	Deceleration Lane Length L_D:	V_D = veh/h
	Freeway Volume, V_F: 1112	
	Ramp Volume, V_R: 249	
	Freeway Free-Flow Speed, S_{FF}: 60.0	
	Ramp Free-Flow Speed, S_{FR}: 45.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	1112	0.90	Level	10	0	0.952	1.00	1297
Ramp	249	0.90	Level	7	0	0.966	1.00	286
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 1.000 using Equation (Exhibit 13-6)

V_{12} = 1297 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	1583	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	1583	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = 13.3 (pc/mi/ln)

LOS = B (Exhibit 13-2)

Speed Determination

M_S = 0.277 (Exibit 13-11)

S_R= 55.0 mph (Exhibit 13-11)

S_0= N/A mph (Exhibit 13-11)

S = 55.0 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-526 WB
Agency or Company	Atkins	Junction	4310-WB On from PaulCantrellEB
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2018 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Number of Lanes, N: 2	☐ Yes ☐ On
☑ No ☐ Off	Acceleration Lane Length, L_A: 700	☑ No ☐ Off
L_{up} = ft	Deceleration Lane Length L_D:	L_{down} = ft
V_u = veh/h	Freeway Volume, V_F: 1057	V_D = veh/h
	Ramp Volume, V_R: 200	
	Freeway Free-Flow Speed, S_{FF}: 60.0	
	Ramp Free-Flow Speed, S_{FR}: 45.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	1057	0.90	Level	8	0	0.962	1.00	1221
Ramp	200	0.90	Level	7	0	0.966	1.00	230
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 1.000 using Equation (Exhibit 13-6)

V_{12} = 1221 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	1451	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	1451	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = 12.3 (pc/mi/ln)

LOS = B (Exhibit 13-2)

Speed Determination

M_S = 0.275 (Exibit 13-11)

S_R= 55.1 mph (Exhibit 13-11)

S_0= N/A mph (Exhibit 13-11)

S = 55.1 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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Appendix E
Traffic Analysis Worksheets

2018 Opening Year

No Action Alternative

US Highway 17

MAJOR MERGE SEGMENTS ANALYSIS

ATKINS

General Information

Date Performed:	7/25/2014	Freeway/Direction	US 17 NB
Analysis Year	2018 No Action	Junction	From I-26 EB & WB
Analysis Time Period:	AM Peak	Segment ID	5010
Project Description:	Navy Base ICTF		

Inputs

	Freeway Upstream of On-Ramp	Freeway Downstream of On-Ramp	On-Ramp
Number of Lanes, N	2	4	2
Free-Flow Speed, FFS (mph)	55	55	55
Volume, V (veh/h)	1,991	3,324	1,333
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	2%	2%	2%
%RVs, P_R	0%	0%	0%

Performance Measures

	Freeway Upstream of On-Ramp	Freeway Downstream of On-Ramp	On-Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.99	0.99	0.99
Demand Flow Rate, v_p (pc/h/ln)	1,117	933	748
Capacity Flow Rate, c (pc/h/ln)	2,250	2,250	2,200
v/c ratio	0.50	0.41	0.34
	Below Capacity	Below Capacity	Below Capacity

Formulas and Reference Material

$$f_{HV} = \frac{1}{1 + P_T(E_T-1)+P_R(E_R-1)}$$ HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P}$$ HCM 2010, Equation 11-2

Basic Freeway Segments Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
75	2,400
70	2,400
65	2,350
60	2,300
55	2,250

Source: HCM 2010, Exhibit 11-17

Ramp Roadways Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

MAJOR MERGE SEGMENTS ANALYSIS

ATKINS

General Information

Date Performed:	7/25/2014	Freeway/Direction	US 17 NB
Analysis Year	2018 No Action	Junction	From I-26 EB & WB
Analysis Time Period:	PM Peak	Segment ID	5010
Project Description:	Navy Base ICTF		

Inputs

	Freeway Upstream of On-Ramp	Freeway Downstream of On-Ramp	On-Ramp
Number of Lanes, N	2	4	2
Free-Flow Speed, FFS (mph)	55	55	55
Volume, V (veh/h)	2,199	2,913	714
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	2%	2%	2%
%RVs, P_R	0%	0%	0%

Performance Measures

	Freeway Upstream of On-Ramp	Freeway Downstream of On-Ramp	On-Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.99	0.99	0.99
Demand Flow Rate, v_p (pc/h/ln)	1,234	817	401
Capacity Flow Rate, c (pc/h/ln)	2,250	2,250	2,200
v/c ratio	0.55	0.36	0.18
	Below Capacity	Below Capacity	Below Capacity

Formulas and Reference Material

$$f_{HV} = \frac{1}{1 + P_T(E_T-1)+P_R(E_R-1)}$$ HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P}$$ HCM 2010, Equation 11-2

Basic Freeway Segments Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
75	2,400
70	2,400
65	2,350
60	2,300
55	2,250

Source: HCM 2010, Exhibit 11-17

Ramp Roadways Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	US-17 NB
Agency or Company	Atkins	Junction	5020-NB On from Meeting
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2018 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Freeway Number of Lanes, N: 4	☐ Yes ☐ On
☑ No ☐ Off	Ramp Number of Lanes, N: 1	☑ No ☐ Off
L_{up} = ft	Acceleration Lane Length, L_A: 1125	L_{down} = ft
V_u = veh/h	Deceleration Lane Length L_D:	V_D = veh/h
	Freeway Volume, V_F: 3324	
	Ramp Volume, V_R: 460	
	Freeway Free-Flow Speed, S_{FF}: 55.0	
	Ramp Free-Flow Speed, S_{FR}: 45.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	3324	0.90	Level	2	0	0.990	1.00	3730
Ramp	460	0.90	Level	10	0	0.952	1.00	537
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 0.151 using Equation (Exhibit 13-6)

V_{12} = 562 pc/h

V_3 or V_{av34} 1584 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * $V_{12}/2$ ☑ Yes ☐ No

If Yes, V_{12a} = 1492 pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	4267	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	2029	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = 14.0 (pc/mi/ln)

LOS = B (Exhibit 13-2)

Speed Determination

M_S = 0.249 (Exibit 13-11)

S_R= 51.8 mph (Exhibit 13-11)

S_0= 52.8 mph (Exhibit 13-11)

S = 52.3 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * $V_{12}/2$ ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	US-17 NB
Agency or Company	Atkins	Junction	5020-NB On from Meeting
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2018 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Freeway Number of Lanes, N: 4	☐ Yes ☐ On
☑ No ☐ Off	Ramp Number of Lanes, N: 1	☑ No ☐ Off
L_{up} = ft	Acceleration Lane Length, L_A: 1125	L_{down} = ft
V_u = veh/h	Deceleration Lane Length L_D:	V_D = veh/h
	Freeway Volume, V_F: 2913	
	Ramp Volume, V_R: 828	
	Freeway Free-Flow Speed, S_{FF}: 55.0	
	Ramp Free-Flow Speed, S_{FR}: 45.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	2913	0.90	Level	2	0	0.990	1.00	3269
Ramp	828	0.90	Level	5	0	0.976	1.00	943
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 0.100 using Equation (Exhibit 13-6)

V_{12} = 327 pc/h

V_3 or V_{av34} 1471 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * $V_{12}/2$ ☑ Yes ☐ No

If Yes, V_{12a} = 1307 pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	4212	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	2250	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = 15.5 (pc/mi/ln)

LOS = B (Exhibit 13-2)

Speed Determination

M_S = 0.257 (Exibit 13-11)

S_R= 51.7 mph (Exhibit 13-11)

S_0= 53.3 mph (Exhibit 13-11)

S = 52.4 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * $V_{12}/2$ ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	US-17 NB
Agency or Company	Atkins	Junction	5030-NB On from E Bay
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2018 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Freeway Number of Lanes, N: 4	☐ Yes ☐ On
☑ No ☐ Off	Ramp Number of Lanes, N: 1	☑ No ☐ Off
L_{up} = ft	Acceleration Lane Length, L_A: 925	L_{down} = ft
V_u = veh/h	Deceleration Lane Length L_D:	V_D = veh/h
	Freeway Volume, V_F: 3784	
	Ramp Volume, V_R: 323	
	Freeway Free-Flow Speed, S_{FF}: 55.0	
	Ramp Free-Flow Speed, S_{FR}: 45.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	3784	0.90	Level	3	0	0.985	1.00	4268
Ramp	323	0.90	Level	14	0	0.935	1.00	384
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 0.170 using Equation (Exhibit 13-6)

V_{12} = 725 pc/h

V_3 or V_{av34} 1771 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * $V_{12}/2$ ☑ Yes ☐ No

If Yes, V_{12a} = 1707 pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	4652	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	2091	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = 15.8 (pc/mi/ln)

LOS = B (Exhibit 13-2)

Speed Determination

M_S = 0.269 (Exibit 13-11)

S_R= 51.5 mph (Exhibit 13-11)

S_0= 52.2 mph (Exhibit 13-11)

S = 51.9 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * $V_{12}/2$ ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	US-17 NB
Agency or Company	Atkins	Junction	5030-NB On from E Bay
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2018 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Freeway Number of Lanes, N: 4	☐ Yes ☐ On
☑ No ☐ Off	Ramp Number of Lanes, N: 1	☑ No ☐ Off
L_{up} = ft	Acceleration Lane Length, L_A: 925	L_{down} = ft
V_u = veh/h	Deceleration Lane Length L_D:	V_D = veh/h
	Freeway Volume, V_F: 3741	
	Ramp Volume, V_R: 1129	
	Freeway Free-Flow Speed, S_{FF}: 55.0	
	Ramp Free-Flow Speed, S_{FR}: 45.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	3741	0.90	Level	2	0	0.990	1.00	4198
Ramp	1129	0.90	Level	3	0	0.985	1.00	1273
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 0.059 using Equation (Exhibit 13-6)

V_{12} = 246 pc/h

V_3 or V_{av34} 1976 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * $V_{12}/2$ ☑ Yes ☐ No

If Yes, V_{12a} = 1679 pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	5471	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	2952	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = 22.1 (pc/mi/ln)

LOS = C (Exhibit 13-2)

Speed Determination

M_S = 0.312 (Exibit 13-11)

S_R= 50.9 mph (Exhibit 13-11)

S_0= 52.3 mph (Exhibit 13-11)

S = 51.5 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * $V_{12}/2$ ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*US-17 NB*
Agency or Company	*Atkins*	From/To	*5040-E Bay to SC-703*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2018 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*4107*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*4*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.980*

Speed Inputs			Calc Speed Adj and FFS		
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f_{LW}		mph
Number of Lanes, N	*4*		f_{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	*55.0*	mph	FFS	*55.0*	mph
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures			Design (N)	
Operational (LOS)			Design (N)	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1164*	pc/h/ln	Design LOS	
			v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h/ln
S	*55.0*	mph	S	mph
D = v_p / S	*21.2*	pc/mi/ln	D = v_p / S	pc/mi/ln
LOS	*C*		Required Number of Lanes, N	

Glossary		Factor Location	
N - Number of lanes	S - Speed	E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
V - Hourly volume	D - Density	E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 11-18	TRD - Page 11-11
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 11-2, 11-3	
DDHV - Directional design hour volume			

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*US-17 NB*
Agency or Company	*Atkins*	From/To	*5040-E Bay to SC-703*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*PM Peak*	Analysis Year	*2018 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*4870*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*3*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.985*

Speed Inputs			Calc Speed Adj and FFS		
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f_{LW}		mph
Number of Lanes, N	*4*		f_{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	*55.0*	mph	FFS	*55.0*	mph
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures			Design (N)	
Operational (LOS)			Design (N)	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1373*	pc/h/ln	Design LOS	
			v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h/ln
S	*55.0*	mph	S	mph
D = v_p / S	*25.0*	pc/mi/ln	D = v_p / S	pc/mi/ln
LOS	*C*		Required Number of Lanes, N	

Glossary		Factor Location	
N - Number of lanes	S - Speed	E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
V - Hourly volume	D - Density	E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 11-18	TRD - Page 11-11
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 11-2, 11-3	
DDHV - Directional design hour volume			

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F-2986

MAJOR DIVERGE SEGMENTS ANALYSIS

ATKINS

General Information

Date Performed:	7/25/2014	Freeway/Direction	US-17 NB
Analysis Year	2018 No Action	Junction	Off to SC-703
Analysis Time Period:	AM Peak	Segment ID	5050
Project Description:	Navy Base ICTF		

Inputs

	Freeway Upstream of Off-Ramp	Freeway Downstream of Off-Ramp	Off-Ramp
Number of Lanes, N	4	2	2
Free-Flow Speed, FFS (mph)	55	45	40
Volume, V (veh/h)	4,107	3,054	1,053
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	4%	2%	8%
%RVs, P_R	0%	0%	0%

Performance Measures

	Upstream of Off-Ramp	Downstream of Off-Ramp	Off-Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.98	0.99	0.96
Demand Flow Rate, v_p (pc/h/ln)	1,164	1,714	608
Capacity Flow Rate, c (pc/h/ln)	2,200	2,100	2,000
v/c ratio	0.53	0.82	0.30
Density, D_{MD} (pc/mi/ln)	20.4	30.0	10.6
LOS	C	D	B

Formulas and Reference Material

$$f_{HV} = \frac{1}{1 + P_T(E_T-1)+P_R(E_R-1)}$$ HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P}$$ HCM 2010, Equation 11-2

$$D_{MD} = \frac{0.0175*v_f}{N}$$ HCM 2010, Equation 13-26

Ramp Roadways Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

Diverge LOS Thresholds

LOS	Density (pc/mi/ln)
A	≤10
B	>10-20
C	>20-28
D	>28-35
E	>35
F	v/c > 1

Source: HCM 2010, Exhibit 13-2

MAJOR DIVERGE SEGMENTS ANALYSIS

ATKINS

General Information

Date Performed:	7/25/2014	Freeway/Direction	US-17 NB
Analysis Year	2018 No Action	Junction	Off to SC-703
Analysis Time Period:	PM Peak	Segment ID	5050
Project Description:	Navy Base ICTF		

Inputs

	Freeway Upstream of Off-Ramp	Freeway Downstream of Off-Ramp	Off-Ramp
Number of Lanes, N	4	2	2
Free-Flow Speed, FFS (mph)	55	45	40
Volume, V (veh/h)	4,870	3,384	1,486
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	3%	2%	5%
%RVs, P_R	0%	0%	0%

Performance Measures

	Upstream of Off-Ramp	Downstream of Off-Ramp	Off-Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.99	0.99	0.98
Demand Flow Rate, v_p (pc/h/ln)	1,373	1,899	846
Capacity Flow Rate, c (pc/h/ln)	2,200	2,100	2,000
v/c ratio	0.62	0.90	0.42
Density, D_{MD} (pc/mi/ln)	24.0	33.2	14.8
LOS	C	D	B

Formulas and Reference Material

$$f_{HV} = \frac{1}{1 + P_T(E_T-1)+P_R(E_R-1)}$$ HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P}$$ HCM 2010, Equation 11-2

$$D_{MD} = \frac{0.0175*v_f}{N}$$ HCM 2010, Equation 13-26

Ramp Roadways Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

Diverge LOS Thresholds

LOS	Density (pc/mi/ln)
A	≤10
B	>10-20
C	>20-28
D	>28-35
E	>35
F	v/c > 1

Source: HCM 2010, Exhibit 13-2

RAMP ADD OR DROP LANE ANALYSIS (MAINLINE <55 MPH)

ATKINS

General Information

Date Performed:	7/25/2014	Freeway/Direction	US-17 NB
Analysis Year	2018 No Action	Junction	Off to Bowman
Analysis Time Period:	AM Peak	Segment ID	5060
Project Description:	Navy Base ICTF		

Inputs

	Mainline Upstream Ramp	Mainline Downstream Ramp	Ramp
Number of Lanes, N	3	2	1
Free-Flow Speed, FFS (mph)	45	45	45
Volume, V (veh/h)	2,381	1,714	667
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	3%	5%	2%
%RVs, P_R	0%	0%	0%

Performance Measures

	Upstream of Off-Ramp	Downstream of Off-Ramp	Off-Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.99	0.98	0.99
Demand Flow Rate, v_p (pc/h/ln)	895	976	749
Capacity Flow Rate, c (pc/h/ln)	2,100	2,100	2,100
v/c ratio	0.43	0.46	0.36
Density, D_{MD} (pc/mi/ln)	15.7	17.1	13.1
LOS	B	B	B

Formulas and Reference Material

$$f_{HV} = \frac{1}{1+P_T(E_T-1)+P_R(E_R-1)}$$ HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P}$$ HCM 2010, Equation 11-2

$$D_{MD} = \frac{0.0175*v_f}{N}$$ HCM 2010, Equation 13-26

Ramp Roadways Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

Diverge LOS Thresholds

LOS	Density (pc/mi/ln)
A	≤10
B	>10-20
C	>20-28
D	>28-35
E	>35
F	v/c > 1

Source: HCM 2010, Exhibit 13-2

RAMP ADD OR DROP LANE ANALYSIS (MAINLINE <55 MPH)

ATKINS

General Information

Date Performed:	7/25/2014	Freeway/Direction	US-17 NB
Analysis Year	2018 No Action	Junction	Off to Bowman
Analysis Time Period:	PM Peak	Segment ID	5060
Project Description:	Navy Base ICTF		

Inputs

	Mainline Upstream Ramp	Mainline Downstream Ramp	Ramp
Number of Lanes, N	3	2	1
Free-Flow Speed, FFS (mph)	45	45	45
Volume, V (veh/h)	3,196	2,498	698
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	2%	4%	2%
%RVs, P_R	0%	0%	0%

Performance Measures

	Upstream of Off-Ramp	Downstream of Off-Ramp	Off-Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.99	0.98	0.99
Demand Flow Rate, v_p (pc/h/ln)	1,196	1,416	783
Capacity Flow Rate, c (pc/h/ln)	2,100	2,100	2,100
v/c ratio	0.57	0.67	0.37
Density, D_{MD} (pc/mi/ln)	20.9	24.8	13.7
LOS	C	C	B

Formulas and Reference Material

$$f_{HV} = \frac{1}{1+P_T(E_T-1)+P_R(E_R-1)}$$ HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P}$$ HCM 2010, Equation 11-2

$$D_{MD} = \frac{0.0175*v_f}{N}$$ HCM 2010, Equation 13-26

Ramp Roadways Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

Diverge LOS Thresholds

LOS	Density (pc/mi/ln)
A	≤10
B	>10-20
C	>20-28
D	>28-35
E	>35
F	v/c > 1

Source: HCM 2010, Exhibit 13-2

BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*US-17 NB*
Agency or Company	*Atkins*	From/To	*5065-Bowman Off to Bowman On*
Date Performed	*4/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2018 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*1714*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*5*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.976*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*55.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*55.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*976*	pc/h/ln
S	*55.0*	mph
D = v_p / S	*17.7*	pc/mi/ln
LOS	*B*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*US-17 NB*
Agency or Company	*Atkins*	From/To	*5065-Bowman Off to Bowman On*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*PM Peak*	Analysis Year	*2018 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*2498*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*4*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.980*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*55.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*55.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1416*	pc/h/ln
S	*55.0*	mph
D = v_p / S	*25.7*	pc/mi/ln
LOS	*C*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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Navy Base ICTF

FREEWAY WEAVING WORKSHEET

General Information

Analyst	AJR
Agency/Company	Atkins
Date Performed	7/25/2014
Analysis Time Period	AM Peak

Site Information

Freeway/Dir of Travel	US-17 NB
Weaving Segment Location	5070-Bowman On to I-526 WB Off
Analysis Year	2018 No Action

Project Description *Navy Base ICTF*

Inputs

Weaving configuration	One-Sided
Weaving number of lanes, N	3
Weaving segment length, L_S	825ft
Freeway free-flow speed, FFS	45 mph
Segment type	C-D Roadway/ Multilane Highways
Freeway minimum speed, S_{MIN}	15
Freeway maximum capacity, C_{IFL}	2250
Terrain type	Level

Conversions to pc/h Under Base Conditions

	V (veh/h)	PHF	Truck (%)	RV (%)	E_T	E_R	f_{HV}	f_p	v (pc/h)
V_{FF}	998	0.90	5	0	1.5	1.2	0.976	1.00	1137
V_{RF}	265	0.90	14	0	1.5	1.2	0.935	1.00	315
V_{FR}	716	0.90	5	0	1.5	1.2	0.976	1.00	815
V_{RR}	191	0.90	14	0	1.5	1.2	0.935	1.00	227
V_{NW}	1364							V =	2494
V_W	1130								
VR	0.453								

Configuration Characteristics

Minimum maneuver lanes, N_{WL}	2 lc
Interchange density, ID	0.3 int/mi
Minimum RF lane changes, LC_{RF}	1 lc/pc
Minimum FR lane changes, LC_{FR}	1 lc/pc
Minimum RR lane changes, LC_{RR}	lc/pc
Minimum weaving lane changes, LC_{MIN}	1130 lc/h
Weaving lane changes, LC_W	1229 lc/h
Non-weaving lane changes, LC_{NW}	150 lc/h
Total lane changes, LC_{ALL}	1379 lc/h
Non-weaving vehicle index, I_{NW}	34

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment flow rate, v	2494 pc/h
Weaving segment capacity, c_w	5140 veh/h
Weaving segment v/c ratio	0.473
Weaving segment density, D	23.9 pc/mi/ln
Level of Service, LOS	B
Weaving intensity factor, W	0.339
Weaving segment speed, S	34.8 mph
Average weaving speed, S_W	37.4 mph
Average non-weaving speed, S_{NW}	32.9 mph
Maximum weaving length, L_{MAX}	7283 ft

Notes

a. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments".
b. For volumes that exceed the weaving segment capacity, the level of service is "F".

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Navy Base ICTF

FREEWAY WEAVING WORKSHEET

General Information

Analyst	AJR
Agency/Company	Atkins
Date Performed	7/25/2014
Analysis Time Period	PM Peak

Site Information

Freeway/Dir of Travel	US-17 NB
Weaving Segment Location	5070-Bowman On to I-526 WB Off
Analysis Year	2018 No Action

Project Description *Navy Base ICTF*

Inputs

Weaving configuration	One-Sided
Weaving number of lanes, N	3
Weaving segment length, L_S	825ft
Freeway free-flow speed, FFS	45 mph
Segment type	C-D Roadway/ Multilane Highways
Freeway minimum speed, S_{MIN}	15
Freeway maximum capacity, C_{IFL}	2250
Terrain type	Level

Conversions to pc/h Under Base Conditions

	V (veh/h)	PHF	Truck (%)	RV (%)	E_T	E_R	f_{HV}	f_p	v (pc/h)
V_{FF}	1829	0.90	4	0	1.5	1.2	0.980	1.00	2073
V_{RF}	593	0.90	7	0	1.5	1.2	0.966	1.00	682
V_{FR}	669	0.90	4	0	1.5	1.2	0.980	1.00	758
V_{RR}	217	0.90	7	0	1.5	1.2	0.966	1.00	250
V_{NW}	2323							V =	3763
V_W	1440								
VR	0.383								

Configuration Characteristics

Minimum maneuver lanes, N_{WL}	2 lc	Minimum weaving lane changes, LC_{MIN}	1440 lc/h
Interchange density, ID	0.3 int/mi	Weaving lane changes, LC_W	1539 lc/h
Minimum RF lane changes, LC_{RF}	1 lc/pc	Non-weaving lane changes, LC_{NW}	348 lc/h
Minimum FR lane changes, LC_{FR}	1 lc/pc	Total lane changes, LC_{ALL}	1887 lc/h
Minimum RR lane changes, LC_{RR}	lc/pc	Non-weaving vehicle index, I_{NW}	57

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment flow rate, v	3763 pc/h	Weaving intensity factor, W	0.434
Weaving segment capacity, c_w	5344 veh/h	Weaving segment speed, S	31.0 mph
Weaving segment v/c ratio	0.690	Average weaving speed, S_W	35.9 mph
Weaving segment density, D	40.4 pc/mi/ln	Average non-weaving speed, S_{NW}	28.6 mph
Level of Service, LOS	E	Maximum weaving length, L_{MAX}	6488 ft

Notes

a. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments".
b. For volumes that exceed the weaving segment capacity, the level of service is "F".

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*US-17 NB*
Agency or Company	*Atkins*	From/To	*5075-526 WB Off to 526 WB On*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2018 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*1263*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*5*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.976*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*55.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*55.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*719*	pc/h/ln
S	*55.0*	mph
D = v_p / S	*13.1*	pc/mi/ln
LOS	*B*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*US-17 NB*
Agency or Company	*Atkins*	From/To	*5075-526 WB Off to 526 WB On*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*PM Peak*	Analysis Year	*2018 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*2422*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*4*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.980*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*55.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*55.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1372*	pc/h/ln
S	*55.0*	mph
D = v_p / S	*24.9*	pc/mi/ln
LOS	*C*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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RAMP ADD OR DROP LANE ANALYSIS (MAINLINE <55 MPH)

ATKINS

General Information

Date Performed:	7/25/2014	Freeway/Direction	US 17 NB
Analysis Year	2018 No Action	Junction	From I-526 WB
Analysis Time Period:	AM Peak	Segment ID	5080
Project Description:	Navy Base ICTF		

Inputs

	Mainline Upstream Ramp	Mainline Downstream Ramp	Ramp
Number of Lanes, N	2	3	1
Free-Flow Speed, FFS (mph)	45	45	45
Volume, V (veh/h)	1,263	1,575	312
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	5%	5%	13%
%RVs, P_R	0%	0%	0%

Performance Measures

	Upstream of Off-Ramp	Downstream of Off-Ramp	Off-Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.98	0.98	0.94
Demand Flow Rate, v_p (pc/h/ln)	719	598	369
Capacity Flow Rate, c (pc/h/ln)	2,100	2,100	2,100
v/c ratio	0.34	0.28	0.18
Density, D_{MD} (pc/mi/ln)	12.6	10.5	6.5
LOS	B	B	A

Formulas and Reference Material

$$f_{HV} = \frac{1}{1+P_T(E_T-1)+P_R(E_R-1)}$$ HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P}$$ HCM 2010, Equation 11-2

$$D_{MD} = \frac{0.0175*v_f}{N}$$ HCM 2010, Equation 13-26

Ramp Roadways Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

Diverge LOS Thresholds

LOS	Density (pc/mi/ln)
A	≤10
B	>10-20
C	>20-28
D	>28-35
E	>35
F	v/c > 1

Source: HCM 2010, Exhibit 13-2

RAMP ADD OR DROP LANE ANALYSIS (MAINLINE <55 MPH)

ATKINS

General Information

Date Performed:	7/25/2014	Freeway/Direction	US 17 NB
Analysis Year	2018 No Action	Junction	From I-526 WB
Analysis Time Period:	PM Peak	Segment ID	5080
Project Description:	Navy Base ICTF		

Inputs

	Mainline Upstream Ramp	Mainline Downstream Ramp	Ramp
Number of Lanes, N	2	3	1
Free-Flow Speed, FFS (mph)	45	45	45
Volume, V (veh/h)	2,422	2,868	446
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	4%	4%	8%
%RVs, P_R	0%	0%	0%

Performance Measures

	Upstream of Off-Ramp	Downstream of Off-Ramp	Off-Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.98	0.98	0.96
Demand Flow Rate, v_p (pc/h/ln)	1,372	1,083	515
Capacity Flow Rate, c (pc/h/ln)	2,100	2,100	2,100
v/c ratio	0.65	0.52	0.25
Density, D_{MD} (pc/mi/ln)	24.0	19.0	9.0
LOS	C	B	A

Formulas and Reference Material

$$f_{HV} = \frac{1}{1+P_T(E_T-1)+P_R(E_R-1)}$$ HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P}$$ HCM 2010, Equation 11-2

$$D_{MD} = \frac{0.0175*v_f}{N}$$ HCM 2010, Equation 13-26

Ramp Roadways Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

Diverge LOS Thresholds

LOS	Density (pc/mi/ln)
A	≤10
B	>10-20
C	>20-28
D	>28-35
E	>35
F	v/c > 1

Source: HCM 2010, Exhibit 13-2

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	US-17 SB
Agency or Company	Atkins	Junction	6010-Off to I-526 EB
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2018 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Number of Lanes, N	2	Downstream Adj Ramp	
☐ Yes	☐ On	Acceleration Lane Length, L_A		☐ Yes	☐ On
☑ No	☐ Off	Deceleration Lane Length L_D	450	☑ No	☐ Off
L_{up} =	ft	Freeway Volume, V_F	2419	L_{down} =	ft
V_u =	veh/h	Ramp Volume, V_R	359	V_D =	veh/h
		Freeway Free-Flow Speed, S_{FF}	55.0		
		Ramp Free-Flow Speed, S_{FR}	45.0		

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	2419	0.90	Level	5	0	0.976	1.00	2755
Ramp	359	0.90	Level	3	0	0.985	1.00	405
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 1.000 using Equation (Exhibit 13-7)

V_{12} = 2755 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	2755	Exhibit 13-8	4500	No
$V_{FO} = V_F - V_R$	2350	Exhibit 13-8	4500	No
V_R	405	Exhibit 13-10	2100	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	2755	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = 23.9 (pc/mi/ln)

LOS = C (Exhibit 13-2)

Speed Determination

D_s = 0.334 (Exhibit 13-12)

S_R= 50.7 mph (Exhibit 13-12)

S_0= N/A mph (Exhibit 13-12)

S = 50.7 mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	US-17 SB
Agency or Company	Atkins	Junction	6010-Off to I-526 EB
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2018 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Number of Lanes, N	2	Downstream Adj Ramp	
☐ Yes	☐ On	Acceleration Lane Length, L_A		☐ Yes	☐ On
☑ No	☐ Off	Deceleration Lane Length L_D	450	☑ No	☐ Off
L_{up} =	ft	Freeway Volume, V_F	1913	L_{down} =	ft
V_u =	veh/h	Ramp Volume, V_R	290	V_D =	veh/h
		Freeway Free-Flow Speed, S_{FF}	55.0		
		Ramp Free-Flow Speed, S_{FR}	45.0		

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	1913	0.90	Level	4	0	0.980	1.00	2168
Ramp	290	0.90	Level	3	0	0.985	1.00	327
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 1.000 using Equation (Exhibit 13-7)

V_{12} = 2168 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	2168	Exhibit 13-8	4500	No
$V_{FO} = V_F - V_R$	1841	Exhibit 13-8	4500	No
V_R	327	Exhibit 13-10	2100	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	2168	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = 18.8 (pc/mi/ln)

LOS = B (Exhibit 13-2)

Speed Determination

D_s = 0.327 (Exhibit 13-12)

S_R= 50.7 mph (Exhibit 13-12)

S_0= N/A mph (Exhibit 13-12)

S = 50.7 mph (Exhibit 13-13)

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*US 17 SB*
Agency or Company	*Atkins*	From/To	*6015-526 EB Off to 526 EB On*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2018 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*2060*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*5*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.976*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*55.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*55.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1173*	pc/h/ln
S	*55.0*	mph
D = v_p / S	*21.3*	pc/mi/ln
LOS	*C*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*US-17 SB*
Agency or Company	*Atkins*	From/To	*6015-526 EB Off to 526 EB On*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*PM Peak*	Analysis Year	*2018 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*1623*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*4*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.980*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*55.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*55.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*920*	pc/h/ln
S	*55.0*	mph
D = v_p / S	*16.7*	pc/mi/ln
LOS	*B*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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Navy Base ICTF

FREEWAY WEAVING WORKSHEET

General Information

Analyst	AJR
Agency/Company	Atkins
Date Performed	7/25/2014
Analysis Time Period	AM Peak

Site Information

Freeway/Dir of Travel	US-17 SB
Weaving Segment Location	6020-I-526 EB On to Bowman Off
Analysis Year	2018 No Action

Project Description *Navy Base ICTF*

Inputs

Weaving configuration	One-Sided
Weaving number of lanes, N	4
Weaving segment length, L_S	650ft
Freeway free-flow speed, FFS	45 mph
Segment type	C-D Roadway/ Multilane Highways
Freeway minimum speed, S_{MIN}	15
Freeway maximum capacity, C_{IFL}	2250
Terrain type	Level

Conversions to pc/h Under Base Conditions

	V (veh/h)	PHF	Truck (%)	RV (%)	E_T	E_R	f_{HV}	f_p	v (pc/h)
V_{FF}	1649	0.90	5	0	1.5	1.2	0.976	1.00	1878
V_{RF}	828	0.90	10	0	1.5	1.2	0.952	1.00	966
V_{FR}	411	0.90	12	0	1.5	1.2	0.943	1.00	484
V_{RR}	206	0.90	12	0	1.5	1.2	0.943	1.00	243
V_{NW}	2121							V =	3571
V_W	1450								
VR	0.406								

Configuration Characteristics

Minimum maneuver lanes, N_{WL}	3 lc
Interchange density, ID	0.3 int/mi
Minimum RF lane changes, LC_{RF}	1 lc/pc
Minimum FR lane changes, LC_{FR}	0 lc/pc
Minimum RR lane changes, LC_{RR}	lc/pc
Minimum weaving lane changes, LC_{MIN}	966 lc/h
Weaving lane changes, LC_W	1110 lc/h
Non-weaving lane changes, LC_{NW}	19 lc/h
Total lane changes, LC_{ALL}	1129 lc/h
Non-weaving vehicle index, I_{NW}	41

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment flow rate, v	3571 pc/h
Weaving segment capacity, c_w	7426 veh/h
Weaving segment v/c ratio	0.469
Weaving segment density, D	25.4 pc/mi/ln
Level of Service, LOS	C
Weaving intensity factor, W	0.349
Weaving segment speed, S	35.1 mph
Average weaving speed, S_W	37.2 mph
Average non-weaving speed, S_{NW}	33.8 mph
Maximum weaving length, L_{MAX}	5183 ft

Notes

a. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments".
b. For volumes that exceed the weaving segment capacity, the level of service is "F".

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Navy Base ICTF

FREEWAY WEAVING WORKSHEET

General Information

Analyst	AJR
Agency/Company	Atkins
Date Performed	7/25/2014
Analysis Time Period	PM Peak

Site Information

Freeway/Dir of Travel	US-17 SB
Weaving Segment Location	6020-I-526 EB On to Bowman Off
Analysis Year	2018 No Action

Project Description *Navy Base ICTF*

Inputs

Weaving configuration	One-Sided
Weaving number of lanes, N	4
Weaving segment length, L_S	650ft
Freeway free-flow speed, FFS	45 mph
Segment type	C-D Roadway/ Multilane Highways
Freeway minimum speed, S_{MIN}	15
Freeway maximum capacity, C_{IFL}	2250
Terrain type	Level

Conversions to pc/h Under Base Conditions

	V (veh/h)	PHF	Truck (%)	RV (%)	E_T	E_R	f_{HV}	f_p	v (pc/h)
V_{FF}	1225	0.90	4	0	1.5	1.2	0.980	1.00	1388
V_{RF}	765	0.90	9	0	1.5	1.2	0.957	1.00	888
V_{FR}	398	0.90	9	0	1.5	1.2	0.957	1.00	462
V_{RR}	248	0.90	9	0	1.5	1.2	0.957	1.00	288
V_{NW}	1676							V =	3026
V_W	1350								
VR	0.446								

Configuration Characteristics

Minimum maneuver lanes, N_{WL}	3 lc
Interchange density, ID	0.3 int/mi
Minimum RF lane changes, LC_{RF}	1 lc/pc
Minimum FR lane changes, LC_{FR}	0 lc/pc
Minimum RR lane changes, LC_{RR}	lc/pc
Minimum weaving lane changes, LC_{MIN}	888 lc/h
Weaving lane changes, LC_W	1032 lc/h
Non-weaving lane changes, LC_{NW}	0 lc/h
Total lane changes, LC_{ALL}	1032 lc/h
Non-weaving vehicle index, I_{NW}	33

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment flow rate, v	3026 pc/h
Weaving segment capacity, c_w	7325 veh/h
Weaving segment v/c ratio	0.405
Weaving segment density, D	20.9 pc/mi/ln
Level of Service, LOS	B
Weaving intensity factor, W	0.325
Weaving segment speed, S	36.1 mph
Average weaving speed, S_W	37.6 mph
Average non-weaving speed, S_{NW}	35.0 mph
Maximum weaving length, L_{MAX}	5638 ft

Notes

a. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments".
b. For volumes that exceed the weaving segment capacity, the level of service is "F".

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*US-17 SB*
Agency or Company	*Atkins*	From/To	*6025-Bowman Off to Bowman On*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2018 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*2477*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*5*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.976*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*55.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*55.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1411*	pc/h/ln
S	*55.0*	mph
D = v_p / S	*25.7*	pc/mi/ln
LOS	*C*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*US-17 SB*
Agency or Company	*Atkins*	From/To	*6025-Bowman Off to Bowman On*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*PM Peak*	Analysis Year	*2018 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*1990*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*4*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.980*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*55.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*55.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1128*	pc/h/ln
S	*55.0*	mph
D = v_p / S	*20.5*	pc/mi/ln
LOS	*C*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	US-17 SB
Agency or Company	Atkins	Junction	6030-SB On from Bowman
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2018 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Number of Lanes, N: 2	☐ Yes ☐ On
☑ No ☐ Off	Acceleration Lane Length, L_A: 900	☑ No ☐ Off
L_{up} = ft	Deceleration Lane Length L_D:	L_{down} = ft
V_u = veh/h	Freeway Volume, V_F: 2477	V_D = veh/h
	Ramp Volume, V_R: 722	
	Freeway Free-Flow Speed, S_{FF}: 55.0	
	Ramp Free-Flow Speed, S_{FR}: 45.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	2477	0.90	Level	5	0	0.976	1.00	2821
Ramp	722	0.90	Level	2	0	0.990	1.00	810
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 1.000 using Equation (Exhibit 13-6)

V_{12} = 2821 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	3631	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	3631	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = 27.8 (pc/mi/ln)

LOS = C (Exhibit 13-2)

Speed Determination

M_S = 0.387 (Exibit 13-11)

S_R= 50.0 mph (Exhibit 13-11)

S_0= N/A mph (Exhibit 13-11)

S = 50.0 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	US-17 SB
Agency or Company	Atkins	Junction	6030-SB On from Bowman
Date Performed	4/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2018 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Number of Lanes, N: 2	☐ Yes ☐ On
☑ No ☐ Off	Acceleration Lane Length, L_A: 900	☑ No ☐ Off
L_{up} = ft	Deceleration Lane Length L_D:	L_{down} = ft
V_u = veh/h	Freeway Volume, V_F: 1990	V_D = veh/h
	Ramp Volume, V_R: 736	
	Freeway Free-Flow Speed, S_{FF}: 55.0	
	Ramp Free-Flow Speed, S_{FR}: 45.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	1990	0.90	Level	4	0	0.980	1.00	2255
Ramp	736	0.90	Level	2	0	0.990	1.00	826
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 1.000 using Equation (Exhibit 13-6)

V_{12} = 2255 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	3081	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	3081	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = 23.5 (pc/mi/ln)

LOS = C (Exhibit 13-2)

Speed Determination

M_S = 0.325 (Exibit 13-11)

S_R= 50.8 mph (Exhibit 13-11)

S_0= N/A mph (Exhibit 13-11)

S = 50.8 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	US-17 SB
Agency or Company	Atkins	Junction	6035-SB On from Wingo Way
Date Performed	4/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2018 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp
☐ Yes ☐ On
☑ No ☐ Off
L_{up} = ft
V_u = veh/h

Freeway Number of Lanes, N	2
Ramp Number of Lanes, N	1
Acceleration Lane Length, L_A	875
Deceleration Lane Length L_D	
Freeway Volume, V_F	2522
Ramp Volume, V_R	771
Freeway Free-Flow Speed, S_{FF}	55.0
Ramp Free-Flow Speed, S_{FR}	45.0

Downstream Adj Ramp
☐ Yes ☐ On
☑ No ☐ Off
L_{down} = ft
V_D = veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	v = V/PHF x f_{HV} x f_p
Freeway	2522	0.90	Level	2	0	0.990	1.00	2830
Ramp	771	0.90	Level	2	0	0.990	1.00	865
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)
P_{FM} = 1.000 using Equation (Exhibit 13-6)
V_{12} = 2830 pc/h
V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)
Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No
Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No
If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	3695	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	3695	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = 28.4 (pc/mi/ln)
LOS = D (Exhibit 13-2)

Speed Determination

M_S = 0.399 (Exibit 13-11)
S_R= 49.8 mph (Exhibit 13-11)
S_0= N/A mph (Exhibit 13-11)
S = 49.8 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)
P_{FD} = using Equation (Exhibit 13-7)
V_{12} = pc/h
V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)
Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No
Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No
If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = (pc/mi/ln)
LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)
S_R= mph (Exhibit 13-12)
S_0= mph (Exhibit 13-12)
S = mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	US-17 SB
Agency or Company	Atkins	Junction	6035-SB On from Wingo Way
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2018 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp
☐ Yes ☐ On
☑ No ☐ Off
L_{up} = ft
V_u = veh/h

Freeway Number of Lanes, N	2
Ramp Number of Lanes, N	1
Acceleration Lane Length, L_A	875
Deceleration Lane Length L_D	
Freeway Volume, V_F	2418
Ramp Volume, V_R	785
Freeway Free-Flow Speed, S_{FF}	55.0
Ramp Free-Flow Speed, S_{FR}	45.0

Downstream Adj Ramp
☐ Yes ☐ On
☑ No ☐ Off
L_{down} = ft
V_D = veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	v = V/PHF x f_{HV} x f_p
Freeway	2418	0.90	Level	2	0	0.990	1.00	2714
Ramp	785	0.90	Level	2	0	0.990	1.00	881
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)
P_{FM} = 1.000 using Equation (Exhibit 13-6)
V_{12} = 2714 pc/h
V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)
Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No
Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No
If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	3595	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	3595	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = 27.6 (pc/mi/ln)
LOS = C (Exhibit 13-2)

Speed Determination

M_S = 0.384 (Exibit 13-11)
S_R= 50.0 mph (Exhibit 13-11)
S_0= N/A mph (Exhibit 13-11)
S = 50.0 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)
P_{FD} = using Equation (Exhibit 13-7)
V_{12} = pc/h
V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)
Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No
Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No
If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = (pc/mi/ln)
LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)
S_R= mph (Exhibit 13-12)
S_0= mph (Exhibit 13-12)
S = mph (Exhibit 13-13)

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MAJOR MERGE SEGMENTS ANALYSIS

ATKINS

General Information

Date Performed:	7/25/2014	Freeway/Direction	US 17 SB
Analysis Year	2018 No Action	Junction	From SC-703
Analysis Time Period:	AM Peak	Segment ID	6040
Project Description:	Navy Base ICTF		

Inputs

	Freeway Upstream of On-Ramp	Freeway Downstream of On-Ramp	On-Ramp
Number of Lanes, N	2	4	2
Free-Flow Speed, FFS (mph)	55	55	40
Volume, V (veh/h)	3,293	4,588	1,295
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	2%	4%	6%
%RVs, P_R	0%	0%	0%

Performance Measures

	Freeway Upstream of On-Ramp	Freeway Downstream of On-Ramp	On-Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.99	0.98	0.97
Demand Flow Rate, v_p (pc/h/ln)	1,848	1,300	741
Capacity Flow Rate, c (pc/h/ln)	2,250	2,250	2,000
v/c ratio	0.82	0.58	0.37
	Below Capacity	Below Capacity	Below Capacity

Formulas and Reference Material

$$f_{HV} = \frac{1}{1 + P_T(E_T-1)+P_R(E_R-1)}$$ HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P}$$ HCM 2010, Equation 11-2

Basic Freeway Segments Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
75	2,400
70	2,400
65	2,350
60	2,300
55	2,250

Source: HCM 2010, Exhibit 11-17

Ramp Roadways Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

MAJOR MERGE SEGMENTS ANALYSIS

ATKINS

General Information

Date Performed:	7/25/2014	Freeway/Direction	US 17 SB
Analysis Year	2018 No Action	Junction	From SC-703
Analysis Time Period:	PM Peak	Segment ID	6040
Project Description:	Navy Base ICTF		

Inputs

	Freeway Upstream of On-Ramp	Freeway Downstream of On-Ramp	On-Ramp
Number of Lanes, N	2	4	2
Free-Flow Speed, FFS (mph)	55	55	40
Volume, V (veh/h)	3,203	4,359	1,156
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	2%	3%	6%
%RVs, P_R	0%	0%	0%

Performance Measures

	Freeway Upstream of On-Ramp	Freeway Downstream of On-Ramp	On-Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.99	0.99	0.97
Demand Flow Rate, v_p (pc/h/ln)	1,797	1,229	661
Capacity Flow Rate, c (pc/h/ln)	2,250	2,250	2,000
v/c ratio	0.80	0.55	0.33
	Below Capacity	Below Capacity	Below Capacity

Formulas and Reference Material

$$f_{HV} = \frac{1}{1 + P_T(E_T-1)+P_R(E_R-1)}$$ HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P}$$ HCM 2010, Equation 11-2

Basic Freeway Segments Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
75	2,400
70	2,400
65	2,350
60	2,300
55	2,250

Source: HCM 2010, Exhibit 11-17

Ramp Roadways Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*US-17 SB*
Agency or Company	*Atkins*	From/To	*6045-SC-703 to E Bay*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2018 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*4588*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*4*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.980*

Speed Inputs			Calc Speed Adj and FFS		
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f_{LW}		mph
Number of Lanes, N	*4*		f_{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	*55.0*	mph	FFS	*55.0*	mph
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures			Design (N)	
Operational (LOS)			Design (N)	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1300*	pc/h/ln	Design LOS	
S	*55.0*	mph	v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h/ln
D = v_p / S	*23.6*	pc/mi/ln	S	mph
LOS	*C*		D = v_p / S	pc/mi/ln
			Required Number of Lanes, N	

Glossary		Factor Location	
N - Number of lanes	S - Speed	E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
V - Hourly volume	D - Density	E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 11-18	TRD - Page 11-11
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 11-2, 11-3	
DDHV - Directional design hour volume			

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*US-17 SB*
Agency or Company	*Atkins*	From/To	*6045-SC-703 to E Bay*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*PM Peak*	Analysis Year	*2018 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*4359*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*3*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.985*

Speed Inputs			Calc Speed Adj and FFS		
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f_{LW}		mph
Number of Lanes, N	*4*		f_{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	*55.0*	mph	FFS	*55.0*	mph
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures			Design (N)	
Operational (LOS)			Design (N)	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1229*	pc/h/ln	Design LOS	
			v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h/ln
S	*55.0*	mph	S	mph
D = v_p / S	*22.3*	pc/mi/ln	D = v_p / S	pc/mi/ln
LOS	*C*		Required Number of Lanes, N	

Glossary		Factor Location	
N - Number of lanes	S - Speed	E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
V - Hourly volume	D - Density	E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 11-18	TRD - Page 11-11
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 11-2, 11-3	
DDHV - Directional design hour volume			

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	US-17 SB
Agency or Company	Atkins	Junction	6050-Off to Morrison
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2018 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Freeway Number of Lanes, N	4	Downstream Adj Ramp	
☐ Yes	☐ On	Ramp Number of Lanes, N	1	☑ Yes	☐ On
☑ No	☐ Off	Acceleration Lane Length, L_A		☐ No	☑ Off
L_{up} =	ft	Deceleration Lane Length L_D	200	L_{down} =	885 ft
V_u =	veh/h	Freeway Volume, V_F	4588	V_D =	473 veh/h
		Ramp Volume, V_R	558		
		Freeway Free-Flow Speed, S_{FF}	55.0		
		Ramp Free-Flow Speed, S_{FR}	45.0		

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	4588	0.90	Level	4	0	0.980	1.00	5200
Ramp	558	0.90	Level	8	0	0.962	1.00	645
UpStream								
DownStream	473	0.90	Level	7	0	0.966	1.00	544

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 0.436 using Equation (Exhibit 13-7)

V_{12} = 2631 pc/h

V_3 or V_{av34} 1284 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	5200	Exhibit 13-8	9000	No
$V_{FO} = V_F - V_R$	4555	Exhibit 13-8	9000	No
V_R	645	Exhibit 13-10	2100	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	2631	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = 25.1 (pc/mi/ln)

LOS = C (Exhibit 13-2)

Speed Determination

D_s = 0.356 (Exhibit 13-12)

S_R= 50.4 mph (Exhibit 13-12)

S_0= 59.2 mph (Exhibit 13-12)

S = 54.4 mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	US-17 SB
Agency or Company	Atkins	Junction	6050-Off to Morrison
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2018 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp

☐ Yes ☐ On

☑ No ☐ Off

L_{up} = ft

V_u = veh/h

Freeway Number of Lanes, N	4
Ramp Number of Lanes, N	1
Acceleration Lane Length, L_A	
Deceleration Lane Length L_D	200
Freeway Volume, V_F	4359
Ramp Volume, V_R	474
Freeway Free-Flow Speed, S_{FF}	55.0
Ramp Free-Flow Speed, S_{FR}	45.0

Downstream Adj Ramp

☑ Yes ☐ On

☐ No ☑ Off

L_{down} = 885 ft

V_D = 343 veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	4359	0.90	Level	3	0	0.985	1.00	4916
Ramp	474	0.90	Level	8	0	0.962	1.00	548
UpStream								
DownStream	343	0.90	Level	8	0	0.962	1.00	396

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 0.436 using Equation (Exhibit 13-7)

V_{12} = 2452 pc/h

V_3 or V_{av34} 1232 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	4916	Exhibit 13-8	9000	No
$V_{FO} = V_F - V_R$	4368	Exhibit 13-8	9000	No
V_R	548	Exhibit 13-10	2100	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	2452	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = 23.5 (pc/mi/ln)

LOS = C (Exhibit 13-2)

Speed Determination

D_s = 0.347 (Exhibit 13-12)

S_R= 50.5 mph (Exhibit 13-12)

S_0= 59.4 mph (Exhibit 13-12)

S = 54.6 mph (Exhibit 13-13)

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FREEWAY RAMP ADD OR DROP LANE ANALYSIS

ATKINS

General Information

Date Performed:	7/25/2014	Freeway/Direction	US-17 SB
Analysis Year	2018 No Action	Junction	Off to Meeting
Analysis Time Period:	AM Peak	Segment ID	6060
Project Description:	Navy Base ICTF		

Inputs

	Freeway Upstream of Ramp	Freeway Downstream of Ramp	Ramp
Number of Lanes, N	4	3	1
Free-Flow Speed, FFS (mph)	55	55	45
Volume, V (veh/h)	4,030	3,557	473
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	3%	2%	7%
%RVs, P_R	0%	0%	0%

Performance Measures

	Freeway Upstream Ramp	Freeway Downstream Ramp	Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.99	0.99	0.97
Demand Flow Rate, v_p (pc/h/ln)	1,136	1,331	544
Capacity Flow Rate, c (pc/h/ln)	2,250	2,250	2,100
v/c ratio	0.50	0.59	0.26
Density, D_{MD} (pc/mi/ln)	19.9	23.3	9.5
LOS	B	C	A

Formulas and Reference Material

$$f_{HV} = \frac{1}{1 + P_T(E_T-1)+P_R(E_R-1)}$$ HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P}$$ HCM 2010, Equation 11-2

$$D_{MD} = \frac{0.0175*v_f}{N}$$ HCM 2010, Equation 13-26

Basic Freeway Segments Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
75	2,400
70	2,400
65	2,350
60	2,300
55	2,250

Source: HCM 2010, Exhibit 11-17

Ramp Roadways Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

Diverge LOS Thresholds

LOS	Density (pc/mi/ln)
A	≤10
B	>10-20
C	>20-28
D	>28-35
E	>35
F	v/c > 1

Source: HCM 2010, Exhibit 13-2

FREEWAY RAMP ADD OR DROP LANE ANALYSIS

ATKINS

General Information

Date Performed:	7/25/2014	Freeway/Direction	US-17 SB
Analysis Year	2018 No Action	Junction	Off to Meeting
Analysis Time Period:	PM Peak	Segment ID	6060
Project Description:	Navy Base ICTF		

Inputs

	Freeway Upstream of Ramp	Freeway Downstream of Ramp	Ramp
Number of Lanes, N	4	3	1
Free-Flow Speed, FFS (mph)	55	55	45
Volume, V (veh/h)	3,885	3,542	343
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	2%	2%	8%
%RVs, P_R	0%	0%	0%

Performance Measures

	Freeway Upstream Ramp	Freeway Downstream Ramp	Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.99	0.99	0.96
Demand Flow Rate, v_p (pc/h/ln)	1,090	1,325	396
Capacity Flow Rate, c (pc/h/ln)	2,250	2,250	2,100
v/c ratio	0.48	0.59	0.19
Density, D_{MD} (pc/mi/ln)	19.1	23.2	6.9
LOS	B	C	A

Formulas and Reference Material

$$f_{HV} = \frac{1}{1 + P_T(E_T-1)+P_R(E_R-1)}$$ HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P}$$ HCM 2010, Equation 11-2

$$D_{MD} = \frac{0.0175*v_f}{N}$$ HCM 2010, Equation 13-26

Basic Freeway Segments Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
75	2,400
70	2,400
65	2,350
60	2,300
55	2,250

Source: HCM 2010, Exhibit 11-17

Ramp Roadways Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

Diverge LOS Thresholds

LOS	Density (pc/mi/ln)
A	≤10
B	>10-20
C	>20-28
D	>28-35
E	>35
F	v/c > 1

Source: HCM 2010, Exhibit 13-2

FREEWAY RAMP ADD OR DROP LANE ANALYSIS

ATKINS

General Information

Date Performed:	7/25/2014	Freeway/Direction	US-17 SB
Analysis Year	2018 No Action	Junction	Off to I-26 WB
Analysis Time Period:	AM Peak	Segment ID	6070
Project Description:	Navy Base ICTF		

Inputs

	Freeway Upstream of Ramp	Freeway Downstream of Ramp	Ramp
Number of Lanes, N	3	2	1
Free-Flow Speed, FFS (mph)	55	55	55
Volume, V (veh/h)	3,557	2,360	1,197
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	2%	2%	2%
%RVs, P_R	0%	0%	0%

Performance Measures

	Freeway Upstream Ramp	Freeway Downstream Ramp	Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.99	0.99	0.99
Demand Flow Rate, v_p (pc/h/ln)	1,331	1,324	1,343
Capacity Flow Rate, c (pc/h/ln)	2,250	2,250	2,200
v/c ratio	0.59	0.59	0.61
Density, D_{MD} (pc/mi/ln)	23.3	23.2	23.5
LOS	C	C	C

Formulas and Reference Material

$$f_{HV} = \frac{1}{1 + P_T(E_T-1)+P_R(E_R-1)}$$ HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P}$$ HCM 2010, Equation 11-2

$$D_{MD} = \frac{0.0175*v_f}{N}$$ HCM 2010, Equation 13-26

Basic Freeway Segments Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
75	2,400
70	2,400
65	2,350
60	2,300
55	2,250

Source: HCM 2010, Exhibit 11-17

Ramp Roadways Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

Diverge LOS Thresholds

LOS	Density (pc/mi/ln)
A	≤10
B	>10-20
C	>20-28
D	>28-35
E	>35
F	v/c > 1

Source: HCM 2010, Exhibit 13-2

FREEWAY RAMP ADD OR DROP LANE ANALYSIS

ATKINS

General Information

Date Performed:	7/25/2014	Freeway/Direction	US-17 SB
Analysis Year	2018 No Action	Junction	Off to I-26 WB
Analysis Time Period:	PM Peak	Segment ID	6070
Project Description:	Navy Base ICTF		

Inputs

	Freeway Upstream of Ramp	Freeway Downstream of Ramp	Ramp
Number of Lanes, N	3	2	1
Free-Flow Speed, FFS (mph)	55	55	55
Volume, V (veh/h)	3,542	2,342	1,200
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	2%	2%	2%
%RVs, P_R	0%	0%	0%

Performance Measures

	Freeway Upstream Ramp	Freeway Downstream Ramp	Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.99	0.99	0.99
Demand Flow Rate, v_p (pc/h/ln)	1,325	1,314	1,347
Capacity Flow Rate, c (pc/h/ln)	2,250	2,250	2,200
v/c ratio	0.59	0.58	0.61
Density, D_{MD} (pc/mi/ln)	23.2	23.0	23.6
LOS	C	C	C

Formulas and Reference Material

$$f_{HV} = \frac{1}{1 + P_T(E_T-1)+P_R(E_R-1)}$$ HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P}$$ HCM 2010, Equation 11-2

$$D_{MD} = \frac{0.0175*v_f}{N}$$ HCM 2010, Equation 13-26

Basic Freeway Segments Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
75	2,400
70	2,400
65	2,350
60	2,300
55	2,250

Source: HCM 2010, Exhibit 11-17

Ramp Roadways Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

Diverge LOS Thresholds

LOS	Density (pc/mi/ln)
A	≤10
B	>10-20
C	>20-28
D	>28-35
E	>35
F	v/c > 1

Source: HCM 2010, Exhibit 13-2

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	150	2848	56	52	2461	60	0	0	76	0	0	61
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	6.0	6.0	6.0	6.0	6.0	6.0			6.0			6.0
Lane Util. Factor	1.00	0.91	1.00	1.00	0.95	1.00			1.00			1.00
Frt	1.00	1.00	0.85	1.00	1.00	0.85			0.86			0.86
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00			1.00			1.00
Satd. Flow (prot)	1770	5085	1583	1770	3539	1583			1611			1580
Flt Permitted	0.95	1.00	1.00	0.95	1.00	1.00			1.00			1.00
Satd. Flow (perm)	1770	5085	1583	1770	3539	1583			1611			1580
Peak-hour factor, PHF	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Adj. Flow (vph)	167	3164	62	58	2734	67	0	0	84	0	0	68
RTOR Reduction (vph)	0	0	9	0	0	12	0	0	20	0	0	20
Lane Group Flow (vph)	167	3164	53	58	2734	55	0	0	64	0	0	48
Heavy Vehicles (%)	2%	2%	2%	2%	2%	2%	2%	2%	2%	4%	4%	4%
Turn Type	Prot	NA	Perm	Prot	NA	Perm			Over			Over
Protected Phases	5	2		1	6				1			5
Permitted Phases			2			6			1			5
Actuated Green, G (s)	15.8	127.4	127.4	10.6	122.2	122.2			10.6			15.8
Effective Green, g (s)	15.8	127.4	127.4	10.6	122.2	122.2			10.6			15.8
Actuated g/C Ratio	0.11	0.85	0.85	0.07	0.81	0.81			0.07			0.11
Clearance Time (s)	6.0	6.0	6.0	6.0	6.0	6.0			6.0			6.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0			3.0			3.0
Lane Grp Cap (vph)	186	4318	1344	125	2883	1289			113			166
v/s Ratio Prot	c0.09	c0.62		0.03	c0.77				0.04			0.03
v/s Ratio Perm			0.03			0.03						
v/c Ratio	0.90	0.73	0.04	0.46	0.95	0.04			0.56			0.29
Uniform Delay, d1	66.3	4.5	1.8	67.0	11.3	2.7			67.5			61.9
Progression Factor	1.00	1.00	1.00	0.77	1.99	0.02			1.00			1.00
Incremental Delay, d2	38.3	1.1	0.1	0.9	3.3	0.0			6.3			1.0
Delay (s)	104.6	5.6	1.8	52.5	25.8	0.1			73.7			62.9
Level of Service	F	A	A	D	C	A			E			E
Approach Delay (s)		10.4			25.8			73.7			62.9	
Approach LOS		B			C			E			E	

Intersection Summary			
HCM 2000 Control Delay	18.7	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity ratio	0.95		
Actuated Cycle Length (s)	150.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	86.3%	ICU Level of Service	E
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	114	3192	78	50	2357	41	0	0	76	0	0	61
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	6.0	6.0	6.0	6.0	6.0	6.0			6.0			6.0
Lane Util. Factor	1.00	0.91	1.00	1.00	0.95	1.00			1.00			1.00
Frt	1.00	1.00	0.85	1.00	1.00	0.85			0.86			0.86
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00			1.00			1.00
Satd. Flow (prot)	1770	5085	1583	1770	3539	1583			1611			1580
Flt Permitted	0.95	1.00	1.00	0.95	1.00	1.00			1.00			1.00
Satd. Flow (perm)	1770	5085	1583	1770	3539	1583			1611			1580
Peak-hour factor, PHF	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Adj. Flow (vph)	127	3547	87	56	2619	46	0	0	84	0	0	68
RTOR Reduction (vph)	0	0	12	0	0	8	0	0	20	0	0	20
Lane Group Flow (vph)	127	3547	75	56	2619	38	0	0	64	0	0	48
Heavy Vehicles (%)	2%	2%	2%	2%	2%	2%	2%	2%	2%	4%	4%	4%
Turn Type	Prot	NA	Perm	Prot	NA	Perm			Over			Over
Protected Phases	5	2		1	6				1			5
Permitted Phases			2			6			1			5
Actuated Green, G (s)	13.9	127.4	127.4	10.6	124.1	124.1			10.6			13.9
Effective Green, g (s)	13.9	127.4	127.4	10.6	124.1	124.1			10.6			13.9
Actuated g/C Ratio	0.09	0.85	0.85	0.07	0.83	0.83			0.07			0.09
Clearance Time (s)	6.0	6.0	6.0	6.0	6.0	6.0			6.0			6.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0			3.0			3.0
Lane Grp Cap (vph)	164	4318	1344	125	2927	1309			113			146
v/s Ratio Prot	c0.07	c0.70		0.03	c0.74				0.04			0.03
v/s Ratio Perm			0.05			0.02						
v/c Ratio	0.77	0.82	0.06	0.45	0.89	0.03			0.56			0.33
Uniform Delay, d1	66.5	5.6	1.8	66.9	8.6	2.3			67.5			63.7
Progression Factor	1.00	1.00	1.00	1.05	1.57	0.05			1.00			1.00
Incremental Delay, d2	20.1	1.9	0.1	1.1	2.2	0.0			6.3			1.3
Delay (s)	86.6	7.5	1.9	71.2	15.8	0.1			73.7			65.0
Level of Service	F	A	A	E	B	A			E			E
Approach Delay (s)		10.0			16.7			73.7			65.0	
Approach LOS		B			B			E			E	

Intersection Summary			
HCM 2000 Control Delay	14.1	HCM 2000 Level of Service	B
HCM 2000 Volume to Capacity ratio	0.89		
Actuated Cycle Length (s)	150.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	82.7%	ICU Level of Service	E
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	414	2169	341	351	2320	117	173	241	175	58	258	80
Number	5	2	12	1	6	16	3	8	18	7	4	14
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1863	1863	1863	1845	1845	1845	1863	1863	1863	1863	1863	1863
Adj Flow Rate, veh/h	460	2410	379	390	2578	130	192	268	194	64	287	89
Adj No. of Lanes	2	3	1	2	3	1	1	2	1	1	2	1
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Percent Heavy Veh, %	2	2	2	3	3	3	2	2	2	2	2	2
Cap, veh/h	459	2729	966	431	2667	918	204	432	393	194	370	377
Arrive On Green	0.27	1.00	1.00	0.13	0.53	0.53	0.07	0.12	0.12	0.06	0.10	0.10
Sat Flow, veh/h	3442	5085	1583	3408	5036	1568	1774	3539	1583	1774	3539	1583
Grp Volume(v), veh/h	460	2410	379	390	2578	130	192	268	194	64	287	89
Grp Sat Flow(s),veh/h/ln	1721	1695	1583	1704	1679	1568	1774	1770	1583	1774	1770	1583
Q Serve(g_s), s	20.0	0.0	0.0	16.9	73.9	5.6	11.0	10.8	15.7	4.7	11.8	6.8
Cycle Q Clear(g_c), s	20.0	0.0	0.0	16.9	73.9	5.6	11.0	10.8	15.7	4.7	11.8	6.8
Prop In Lane	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Lane Grp Cap(c), veh/h	459	2729	966	431	2667	918	204	432	393	194	370	377
V/C Ratio(X)	1.00	0.88	0.39	0.91	0.97	0.14	0.94	0.62	0.49	0.33	0.78	0.24
Avail Cap(c_a), veh/h	459	2729	966	432	2667	918	204	432	393	201	378	380
HCM Platoon Ratio	2.00	2.00	2.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	0.61	0.61	0.61	0.13	0.13	0.13	1.00	1.00	1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	54.9	0.0	0.0	64.6	34.0	14.0	60.3	62.5	48.2	55.0	65.4	46.1
Incr Delay (d2), s/veh	33.1	2.9	0.7	4.1	2.3	0.0	46.7	2.7	1.0	1.0	9.6	0.3
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	11.4	0.7	0.2	8.2	34.7	2.4	5.2	5.4	7.0	2.4	6.3	3.0
LnGrp Delay(d),s/veh	88.0	2.9	0.7	68.7	36.2	14.1	107.0	65.2	49.2	56.0	75.0	46.4
LnGrp LOS	F	A	A	E	D	B	F	E	D	E	E	D
Approach Vol, veh/h		3249			3098			654			440	
Approach Delay, s/veh		14.7			39.4			72.7			66.4	
Approach LOS		B			D			E			E	

Timer	1	2	3	4	5	6	7	8
Assigned Phs	1	2	3	4	5	6	7	8
Phs Duration (G+Y+Rc), s	24.9	86.4	17.0	21.7	26.0	85.3	14.4	24.3
Change Period (Y+Rc), s	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0
Max Green Setting (Gmax), s	19.0	80.0	11.0	16.0	20.0	79.0	9.0	18.0
Max Q Clear Time (g_c+I1), s	18.9	2.0	13.0	13.8	22.0	75.9	6.7	17.7
Green Ext Time (p_c), s	0.0	76.6	0.0	0.7	0.0	3.1	0.0	0.1

Intersection Summary	
HCM 2010 Ctrl Delay	33.1
HCM 2010 LOS	C

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	419	2532	317	300	2055	130	220	269	320	110	226	173
Number	5	2	12	1	6	16	3	8	18	7	4	14
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1863	1863	1863	1863	1863	1863	1863	1863	1863	1863	1863	1863
Adj Flow Rate, veh/h	466	2813	352	333	2283	144	244	299	356	122	251	192
Adj No. of Lanes	2	3	1	2	3	1	1	2	1	1	2	1
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Percent Heavy Veh, %	2	2	2	2	2	2	2	2	2	2	2	2
Cap, veh/h	504	2780	1013	321	2510	898	250	448	348	214	378	401
Arrive On Green	0.29	1.00	1.00	0.09	0.49	0.49	0.09	0.13	0.13	0.07	0.11	0.11
Sat Flow, veh/h	3442	5085	1583	3442	5085	1583	1774	3539	1583	1774	3539	1583
Grp Volume(v), veh/h	466	2813	352	333	2283	144	244	299	356	122	251	192
Grp Sat Flow(s),veh/h/ln	1721	1695	1583	1721	1695	1583	1774	1770	1583	1774	1770	1583
Q Serve(g_s), s	19.7	82.0	0.0	14.0	61.9	6.5	14.0	12.1	19.0	9.1	10.2	15.5
Cycle Q Clear(g_c), s	19.7	82.0	0.0	14.0	61.9	6.5	14.0	12.1	19.0	9.1	10.2	15.5
Prop In Lane	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Lane Grp Cap(c), veh/h	504	2780	1013	321	2510	898	250	448	348	214	378	401
V/C Ratio(X)	0.92	1.01	0.35	1.04	0.91	0.16	0.98	0.67	1.02	0.57	0.66	0.48
Avail Cap(c_a), veh/h	528	2780	1013	321	2510	898	250	448	348	214	378	401
HCM Platoon Ratio	2.00	2.00	2.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	0.47	0.47	0.47	0.30	0.30	0.30	1.00	1.00	1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	52.2	0.0	0.0	68.0	34.9	15.5	59.0	62.5	58.5	54.5	64.4	47.6
Incr Delay (d2), s/veh	12.4	14.7	0.4	37.6	2.1	0.1	50.2	3.7	54.0	3.6	4.4	0.9
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	10.2	3.8	0.1	8.3	29.4	2.9	6.8	6.2	19.6	4.7	5.2	6.9
LnGrp Delay(d),s/veh	64.6	14.7	0.4	105.6	37.0	15.6	109.2	66.2	112.5	58.1	68.8	48.5
LnGrp LOS	E	F	A	F	D	B	F	E	F	E	E	D
Approach Vol, veh/h		3631			2760			899			565	
Approach Delay, s/veh		19.8			44.1			96.2			59.6	
Approach LOS		B			D			F			E	

Timer	1	2	3	4	5	6	7	8
Assigned Phs	1	2	3	4	5	6	7	8
Phs Duration (G+Y+Rc), s	20.0	88.0	20.0	22.0	28.0	80.0	17.0	25.0
Change Period (Y+Rc), s	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0
Max Green Setting (Gmax), s	14.0	82.0	14.0	16.0	23.0	73.0	11.0	19.0
Max Q Clear Time (g_c+I1), s	16.0	84.0	16.0	17.5	21.7	63.9	11.1	21.0
Green Ext Time (p_c), s	0.0	0.0	0.0	0.0	0.3	9.1	0.0	0.0

Intersection Summary	
HCM 2010 Ctrl Delay	39.9
HCM 2010 LOS	D

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	251	1976	175	188	2463	257	124	194	171	177	216	201
Number	5	2	12	1	6	16	3	8	18	7	4	14
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1845	1845	1845	1845	1845	1845	1845	1845	1845	1863	1863	1863
Adj Flow Rate, veh/h	279	2196	194	209	2737	286	138	216	190	197	240	223
Adj No. of Lanes	1	3	1	1	3	1	1	1	1	2	1	1
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Percent Heavy Veh, %	3	3	3	3	3	3	3	3	3	2	2	2
Cap, veh/h	247	2818	992	233	2686	930	129	246	346	206	224	369
Arrive On Green	0.11	0.56	0.56	0.06	0.36	0.36	0.07	0.13	0.13	0.06	0.12	0.12
Sat Flow, veh/h	1757	5036	1568	1757	5036	1568	1757	1845	1568	3442	1863	1583
Grp Volume(v), veh/h	279	2196	194	209	2737	286	138	216	190	197	240	223
Grp Sat Flow(s),veh/h/ln	1757	1679	1568	1757	1679	1568	1757	1845	1568	1721	1863	1583
Q Serve(g_s), s	17.0	51.1	7.8	10.9	80.0	17.5	11.0	17.2	16.1	8.6	18.0	18.0
Cycle Q Clear(g_c), s	17.0	51.1	7.8	10.9	80.0	17.5	11.0	17.2	16.1	8.6	18.0	18.0
Prop In Lane	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Lane Grp Cap(c), veh/h	247	2818	992	233	2686	930	129	246	346	206	224	369
V/C Ratio(X)	1.13	0.78	0.20	0.90	1.02	0.31	1.07	0.88	0.55	0.95	1.07	0.60
Avail Cap(c_a), veh/h	247	2818	992	279	2686	930	129	246	346	206	224	369
HCM Platoon Ratio	1.00	1.00	1.00	0.67	0.67	0.67	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	0.43	0.43	0.43	0.59	0.59	0.59	1.00	1.00	1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	54.6	25.8	11.5	43.3	48.2	22.0	69.5	63.8	51.9	70.3	66.0	51.3
Incr Delay (d2), s/veh	78.5	1.0	0.2	17.5	18.4	0.5	99.6	28.2	1.8	49.5	81.1	2.8
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	15.6	23.8	3.4	9.7	41.7	7.7	8.9	10.7	7.1	5.5	14.3	8.5
LnGrp Delay(d),s/veh	133.1	26.8	11.7	60.9	66.6	22.5	169.1	92.0	53.7	119.8	147.1	54.1
LnGrp LOS	F	C	B	E	F	C	F	F	D	F	F	D
Approach Vol, veh/h		2669			3232			544			660	
Approach Delay, s/veh		36.8			62.3			98.2			107.5	
Approach LOS		D			E			F			F	

Timer	1	2	3	4	5	6	7	8
Assigned Phs	1	2	3	4	5	6	7	8
Phs Duration (G+Y+Rc), s	19.1	89.9	17.0	24.0	23.0	86.0	15.0	26.0
Change Period (Y+Rc), s	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0
Max Green Setting (Gmax), s	17.0	80.0	11.0	18.0	17.0	80.0	9.0	20.0
Max Q Clear Time (g_c+I1), s	12.9	53.1	13.0	20.0	19.0	82.0	10.6	19.2
Green Ext Time (p_c), s	0.2	26.7	0.0	0.0	0.0	0.0	0.0	0.4

Intersection Summary	
HCM 2010 Ctrl Delay	59.7
HCM 2010 LOS	E

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	306	2534	122	199	2141	156	105	178	243	195	206	239
Number	5	2	12	1	6	16	3	8	18	7	4	14
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1863	1863	1863	1863	1863	1863	1863	1863	1863	1863	1863	1863
Adj Flow Rate, veh/h	340	2816	136	221	2379	173	117	198	270	217	229	266
Adj No. of Lanes	1	3	1	1	3	1	1	1	1	2	1	1
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Percent Heavy Veh, %	2	2	2	2	2	2	2	2	2	2	2	2
Cap, veh/h	338	2848	992	215	2509	887	118	224	338	229	224	443
Arrive On Green	0.16	0.56	0.56	0.09	0.49	0.49	0.07	0.12	0.12	0.07	0.12	0.12
Sat Flow, veh/h	1774	5085	1583	1774	5085	1583	1774	1863	1583	3442	1863	1583
Grp Volume(v), veh/h	340	2816	136	221	2379	173	117	198	270	217	229	266
Grp Sat Flow(s),veh/h/ln	1774	1695	1583	1774	1695	1583	1774	1863	1583	1721	1863	1583
Q Serve(g_s), s	24.0	81.9	5.3	14.0	66.8	8.1	9.9	15.7	18.0	9.4	18.0	18.0
Cycle Q Clear(g_c), s	24.0	81.9	5.3	14.0	66.8	8.1	9.9	15.7	18.0	9.4	18.0	18.0
Prop In Lane	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Lane Grp Cap(c), veh/h	338	2848	992	215	2509	887	118	224	338	229	224	443
V/C Ratio(X)	1.01	0.99	0.14	1.03	0.95	0.20	0.99	0.89	0.80	0.95	1.02	0.60
Avail Cap(c_a), veh/h	338	2848	992	215	2509	887	118	224	338	229	224	443
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	0.18	0.18	0.18	0.74	0.74	0.74	1.00	1.00	1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	53.0	32.5	11.4	52.2	36.2	16.3	69.9	65.0	56.0	69.7	66.0	46.7
Incr Delay (d2), s/veh	22.1	5.0	0.1	60.6	7.4	0.4	79.2	31.7	12.7	44.4	66.7	2.2
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0
%ile BackOfQ(50%),veh/ln	16.1	39.4	2.3	12.5	32.8	3.6	7.4	10.1	11.8	5.9	13.4	9.8
LnGrp Delay(d),s/veh	75.2	37.5	11.5	112.9	43.6	16.7	149.2	96.7	68.7	114.1	132.8	49.0
LnGrp LOS	F	D	B	F	D	B	F	F	E	F	F	D
Approach Vol, veh/h		3292			2773			585			712	
Approach Delay, s/veh		40.3			47.4			94.3			95.8	
Approach LOS		D			D			F			F	

Timer	1	2	3	4	5	6	7	8
Assigned Phs	1	2	3	4	5	6	7	8
Phs Duration (G+Y+Rc), s	20.0	90.0	16.0	24.0	30.0	80.0	16.0	24.0
Change Period (Y+Rc), s	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0
Max Green Setting (Gmax), s	14.0	84.0	10.0	18.0	24.0	74.0	10.0	18.0
Max Q Clear Time (g_c+I1), s	16.0	83.9	11.9	20.0	26.0	68.8	11.4	20.0
Green Ext Time (p_c), s	0.0	0.1	0.0	0.0	0.0	5.2	0.0	0.0

Intersection Summary	
HCM 2010 Ctrl Delay	52.6
HCM 2010 LOS	D

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Volume (veh/h)	2217	107	111	2834	74	106
Number	2	12	1	6	3	18
Initial Q (Qb), veh	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)		1.00	1.00		1.00	1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1845	1845	1845	1845	1863	1863
Adj Flow Rate, veh/h	2463	119	123	3149	82	118
Adj No. of Lanes	3	1	1	3	1	1
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90
Percent Heavy Veh, %	3	3	3	3	2	2
Cap, veh/h	3747	1298	243	4253	148	227
Arrive On Green	1.00	1.00	0.12	1.00	0.08	0.08
Sat Flow, veh/h	5202	1568	1757	5202	1774	1583
Grp Volume(v), veh/h	2463	119	123	3149	82	118
Grp Sat Flow(s),veh/h/ln	1679	1568	1757	1679	1774	1583
Q Serve(g_s), s	0.0	0.0	2.1	0.0	6.6	10.3
Cycle Q Clear(g_c), s	0.0	0.0	2.1	0.0	6.6	10.3
Prop In Lane		1.00	1.00		1.00	1.00
Lane Grp Cap(c), veh/h	3747	1298	243	4253	148	227
V/C Ratio(X)	0.66	0.09	0.51	0.74	0.55	0.52
Avail Cap(c_a), veh/h	3747	1298	338	4253	179	255
HCM Platoon Ratio	2.00	2.00	2.00	2.00	1.00	1.00
Upstream Filter(I)	0.52	0.52	0.09	0.09	1.00	1.00
Uniform Delay (d), s/veh	0.0	0.0	2.9	0.0	65.5	58.9
Incr Delay (d2), s/veh	0.5	0.1	0.1	0.1	3.2	1.8
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	0.2	0.0	0.9	0.0	3.4	4.6
LnGrp Delay(d),s/veh	0.5	0.1	3.0	0.1	68.7	60.8
LnGrp LOS	A	A	A	A	E	E
Approach Vol, veh/h	2582			3272	200	
Approach Delay, s/veh	0.5			0.2	64.0	
Approach LOS	A			A	E	

Timer	1	2	3	4	5	6	7	8
Assigned Phs	1	2				6		8
Phs Duration (G+Y+Rc), s	14.9	116.7				131.6		18.4
Change Period (Y+Rc), s	6.0	6.0				6.0		6.0
Max Green Setting (Gmax), s	17.0	100.0				123.0		15.0
Max Q Clear Time (g_c+I1), s	4.1	2.0				2.0		12.3
Green Ext Time (p_c), s	0.2	97.1				119.6		0.2

Intersection Summary	
HCM 2010 Ctrl Delay	2.4
HCM 2010 LOS	A

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Volume (veh/h)	2872	100	128	2427	69	148
Number	2	12	1	6	3	18
Initial Q (Qb), veh	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)		1.00	1.00		1.00	1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1863	1863	1863	1863	1863	1863
Adj Flow Rate, veh/h	3191	111	142	2697	77	164
Adj No. of Lanes	3	1	1	3	1	1
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90
Percent Heavy Veh, %	2	2	2	2	2	2
Cap, veh/h	3798	1299	198	4306	130	211
Arrive On Green	1.00	1.00	0.12	1.00	0.07	0.07
Sat Flow, veh/h	5253	1583	1774	5253	1774	1583
Grp Volume(v), veh/h	3191	111	142	2697	77	164
Grp Sat Flow(s),veh/h/ln	1695	1583	1774	1695	1774	1583
Q Serve(g_s), s	0.0	0.0	3.4	0.0	6.3	11.0
Cycle Q Clear(g_c), s	0.0	0.0	3.4	0.0	6.3	11.0
Prop In Lane		1.00	1.00		1.00	1.00
Lane Grp Cap(c), veh/h	3798	1299	198	4306	130	211
V/C Ratio(X)	0.84	0.09	0.72	0.63	0.59	0.78
Avail Cap(c_a), veh/h	3798	1299	245	4306	130	211
HCM Platoon Ratio	2.00	2.00	2.00	2.00	1.00	1.00
Upstream Filter(I)	0.20	0.20	0.32	0.32	1.00	1.00
Uniform Delay (d), s/veh	0.0	0.0	28.0	0.0	67.3	62.9
Incr Delay (d2), s/veh	0.5	0.0	2.5	0.2	7.0	16.7
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	0.2	0.0	5.6	0.1	3.4	7.5
LnGrp Delay(d),s/veh	0.5	0.0	30.5	0.2	74.3	79.6
LnGrp LOS	A	A	C	A	E	E
Approach Vol, veh/h	3302			2839	241	
Approach Delay, s/veh	0.5			1.7	77.9	
Approach LOS	A			A	E	

Timer	1	2	3	4	5	6	7	8
Assigned Phs	1	2				6		8
Phs Duration (G+Y+Rc), s	15.0	118.0				133.0		17.0
Change Period (Y+Rc), s	6.0	6.0				6.0		6.0
Max Green Setting (Gmax), s	13.0	108.0				127.0		11.0
Max Q Clear Time (g_c+I1), s	5.4	2.0				2.0		13.0
Green Ext Time (p_c), s	0.2	105.1				123.7		0.0

Intersection Summary	
HCM 2010 Ctrl Delay	4.0
HCM 2010 LOS	A

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	222	1990	111	190	2652	357	146	80	177	214	90	147
Number	5	2	12	1	6	16	3	8	18	7	4	14
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1845	1845	1845	1845	1845	1845	1863	1863	1863	1863	1863	1863
Adj Flow Rate, veh/h	247	2211	123	211	2947	397	162	89	197	238	100	163
Adj No. of Lanes	1	3	1	1	3	1	2	1	1	2	1	1
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Percent Heavy Veh, %	3	3	3	3	3	3	2	2	2	2	2	2
Cap, veh/h	212	2806	1041	252	2686	1003	378	199	279	378	199	317
Arrive On Green	0.19	1.00	1.00	0.07	0.53	0.53	0.11	0.11	0.11	0.11	0.11	0.11
Sat Flow, veh/h	1757	5036	1568	1757	5036	1568	3548	1863	1583	3548	1863	1583
Grp Volume(v), veh/h	247	2211	123	211	2947	397	162	89	197	238	100	163
Grp Sat Flow(s),veh/h/ln	1757	1679	1568	1757	1679	1568	1774	1863	1583	1774	1863	1583
Q Serve(g_s), s	14.0	0.0	0.0	8.1	80.0	18.3	6.4	6.7	16.0	9.6	7.6	13.8
Cycle Q Clear(g_c), s	14.0	0.0	0.0	8.1	80.0	18.3	6.4	6.7	16.0	9.6	7.6	13.8
Prop In Lane	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Lane Grp Cap(c), veh/h	212	2806	1041	252	2686	1003	378	199	279	378	199	317
V/C Ratio(X)	1.17	0.79	0.12	0.84	1.10	0.40	0.43	0.45	0.71	0.63	0.50	0.51
Avail Cap(c_a), veh/h	212	2806	1041	329	2686	1003	378	199	279	378	199	317
HCM Platoon Ratio	2.00	2.00	2.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	0.69	0.69	0.69	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	46.7	0.0	0.0	19.3	35.0	13.0	62.7	62.9	58.1	64.2	63.2	53.5
Incr Delay (d2), s/veh	103.8	1.6	0.2	13.7	50.3	1.2	0.8	1.6	7.9	3.3	2.0	1.4
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	14.8	0.4	0.0	5.5	49.3	10.6	3.2	3.5	8.3	4.9	4.0	6.1
LnGrp Delay(d),s/veh	150.6	1.6	0.2	33.0	85.3	14.2	63.5	64.4	66.0	67.5	65.3	54.9
LnGrp LOS	F	A	A	C	F	B	E	E	E	E	E	D
Approach Vol, veh/h		2581			3555			448			501	
Approach Delay, s/veh		15.8			74.3			64.8			62.9	
Approach LOS		B			E			E			E	

Timer	1	2	3	4	5	6	7	8
Assigned Phs	1	2		4	5	6		8
Phs Duration (G+Y+Rc), s	16.4	89.6		22.0	20.0	86.0		22.0
Change Period (Y+Rc), s	6.0	6.0		6.0	6.0	6.0		6.0
Max Green Setting (Gmax), s	17.0	77.0		16.0	14.0	80.0		16.0
Max Q Clear Time (g_c+I1), s	10.1	2.0		15.8	16.0	82.0		18.0
Green Ext Time (p_c), s	0.3	74.1		0.1	0.0	0.0		0.0

Intersection Summary	
HCM 2010 Ctrl Delay	51.6
HCM 2010 LOS	D

Notes

User approved volume balancing among the lanes for turning movement.

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	208	2694	118	193	2266	267	114	95	188	314	170	175
Number	5	2	12	1	6	16	3	8	18	7	4	14
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1863	1863	1863	1863	1863	1863	1863	1863	1863	1863	1863	1863
Adj Flow Rate, veh/h	231	2993	131	214	2518	297	130	102	209	349	189	194
Adj No. of Lanes	1	3	1	1	3	1	2	1	1	2	1	1
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Percent Heavy Veh, %	2	2	2	2	2	2	2	2	2	2	2	2
Cap, veh/h	231	2814	1045	215	2678	1003	378	199	285	378	199	327
Arrive On Green	0.20	1.00	1.00	0.07	0.53	0.53	0.11	0.11	0.11	0.11	0.11	0.11
Sat Flow, veh/h	1774	5085	1583	1774	5085	1583	3548	1863	1583	3548	1863	1583
Grp Volume(v), veh/h	231	2993	131	214	2518	297	130	102	209	349	189	194
Grp Sat Flow(s),veh/h/ln	1774	1695	1583	1774	1695	1583	1774	1863	1583	1774	1863	1583
Q Serve(g_s), s	15.0	0.0	0.0	10.9	69.6	12.7	5.1	7.8	16.0	14.6	15.1	16.0
Cycle Q Clear(g_c), s	15.0	0.0	0.0	10.9	69.6	12.7	5.1	7.8	16.0	14.6	15.1	16.0
Prop In Lane	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Lane Grp Cap(c), veh/h	231	2814	1045	215	2678	1003	378	199	285	378	199	327
V/C Ratio(X)	1.00	1.06	0.13	1.00	0.94	0.30	0.34	0.51	0.73	0.92	0.95	0.59
Avail Cap(c_a), veh/h	231	2814	1045	215	2678	1003	378	199	285	378	199	327
HCM Platoon Ratio	2.00	2.00	2.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	0.42	0.42	0.42	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	45.0	0.0	0.0	36.8	33.3	12.4	62.1	63.3	58.1	66.4	66.6	53.8
Incr Delay (d2), s/veh	37.9	32.6	0.1	60.3	8.1	0.8	0.5	2.2	9.4	27.6	49.9	2.9
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	11.9	8.5	0.0	12.4	34.4	7.4	2.5	4.1	8.9	8.6	10.6	7.5
LnGrp Delay(d),s/veh	82.9	32.6	0.1	97.1	41.4	13.2	62.7	65.6	67.5	94.0	116.5	56.6
LnGrp LOS	F	F	A	F	D	B	E	E	E	F	F	E
Approach Vol, veh/h		3355			3029			441			732	
Approach Delay, s/veh		34.8			42.6			65.6			89.9	
Approach LOS		C			D			E			F	

Timer	1	2	3	4	5	6	7	8
Assigned Phs	1	2		4	5	6		8
Phs Duration (G+Y+Rc), s	17.0	89.0		22.0	21.0	85.0		22.0
Change Period (Y+Rc), s	6.0	6.0		6.0	6.0	6.0		6.0
Max Green Setting (Gmax), s	11.0	83.0		16.0	15.0	79.0		16.0
Max Q Clear Time (g_c+I1), s	12.9	2.0		18.0	17.0	71.6		18.0
Green Ext Time (p_c), s	0.0	80.4		0.0	0.0	7.4		0.0

Intersection Summary	
HCM 2010 Ctrl Delay	45.0
HCM 2010 LOS	D

Notes

User approved volume balancing among the lanes for turning movement.

Appendix E
Traffic Analysis Worksheets

2018 Opening Year

No Action Alternative

North Charleston Intersections

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	0	0	0	0	172	0	0	0	0	0	1575	383
Number				7	4	14				5	2	12
Initial Q (Qb), veh				0	0	0				0	0	0
Ped-Bike Adj(A_pbT)				1.00		1.00				1.00		1.00
Parking Bus, Adj				1.00	1.00	1.00				1.00	1.00	1.00
Adj Sat Flow, veh/h/ln				0	1810	0				0	1827	1827
Adj Flow Rate, veh/h				0	191	0				0	1750	426
Adj No. of Lanes				0	2	0				0	3	1
Peak Hour Factor				0.90	0.90	0.90				0.90	0.90	0.90
Percent Heavy Veh, %				0	5	0				0	4	4
Cap, veh/h				0	521	0				0	3171	987
Arrive On Green				0.00	0.15	0.00				0.00	0.64	0.64
Sat Flow, veh/h				0	3619	0				0	5152	1553
Grp Volume(v), veh/h				0	191	0				0	1750	426
Grp Sat Flow(s),veh/h/ln				0	1719	0				0	1663	1553
Q Serve(g_s), s				0.0	2.8	0.0				0.0	11.1	7.8
Cycle Q Clear(g_c), s				0.0	2.8	0.0				0.0	11.1	7.8
Prop In Lane				0.00		0.00				0.00		1.00
Lane Grp Cap(c), veh/h				0	521	0				0	3171	987
V/C Ratio(X)				0.00	0.37	0.00				0.00	0.55	0.43
Avail Cap(c_a), veh/h				0	914	0				0	5570	1734
HCM Platoon Ratio				1.00	1.00	1.00				1.00	1.00	1.00
Upstream Filter(I)				0.00	1.00	0.00				0.00	1.00	1.00
Uniform Delay (d), s/veh				0.0	21.5	0.0				0.0	5.8	5.2
Incr Delay (d2), s/veh				0.0	0.4	0.0				0.0	0.2	0.3
Initial Q Delay(d3),s/veh				0.0	0.0	0.0				0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln				0.0	1.4	0.0				0.0	5.1	3.4
LnGrp Delay(d),s/veh				0.0	21.9	0.0				0.0	5.9	5.5
LnGrp LOS					C						A	A
Approach Vol, veh/h					191						2176	
Approach Delay, s/veh					21.9						5.8	
Approach LOS					C						A	

Timer	1	2	3	4	5	6	7	8
Assigned Phs		2		4				
Phs Duration (G+Y+Rc), s		41.9		14.5				
Change Period (Y+Rc), s		6.0		6.0				
Max Green Setting (Gmax), s		63.0		15.0				
Max Q Clear Time (g_c+I1), s		13.1		4.8				
Green Ext Time (p_c), s		22.8		0.7				

Intersection Summary	
HCM 2010 Ctrl Delay	7.1
HCM 2010 LOS	A

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	0	0	0	0	217	0	0	0	0	0	933	287
Number				7	4	14				5	2	12
Initial Q (Qb), veh				0	0	0				0	0	0
Ped-Bike Adj(A_pbT)				1.00		1.00				1.00		1.00
Parking Bus, Adj				1.00	1.00	1.00				1.00	1.00	1.00
Adj Sat Flow, veh/h/ln				0	1810	0				0	1845	1845
Adj Flow Rate, veh/h				0	241	0				0	1037	319
Adj No. of Lanes				0	2	0				0	3	1
Peak Hour Factor				0.90	0.90	0.90				0.90	0.90	0.90
Percent Heavy Veh, %				0	5	0				0	3	3
Cap, veh/h				0	758	0				0	2316	721
Arrive On Green				0.00	0.22	0.00				0.00	0.46	0.46
Sat Flow, veh/h				0	3619	0				0	5202	1568
Grp Volume(v), veh/h				0	241	0				0	1037	319
Grp Sat Flow(s),veh/h/ln				0	1719	0				0	1679	1568
Q Serve(g_s), s				0.0	2.2	0.0				0.0	5.3	5.2
Cycle Q Clear(g_c), s				0.0	2.2	0.0				0.0	5.3	5.2
Prop In Lane				0.00		0.00				0.00		1.00
Lane Grp Cap(c), veh/h				0	758	0				0	2316	721
V/C Ratio(X)				0.00	0.32	0.00				0.00	0.45	0.44
Avail Cap(c_a), veh/h				0	2290	0				0	7112	2215
HCM Platoon Ratio				1.00	1.00	1.00				1.00	1.00	1.00
Upstream Filter(I)				0.00	1.00	0.00				0.00	1.00	1.00
Uniform Delay (d), s/veh				0.0	12.3	0.0				0.0	6.9	6.9
Incr Delay (d2), s/veh				0.0	0.2	0.0				0.0	0.1	0.4
Initial Q Delay(d3),s/veh				0.0	0.0	0.0				0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln				0.0	1.1	0.0				0.0	2.4	2.3
LnGrp Delay(d),s/veh				0.0	12.5	0.0				0.0	7.0	7.3
LnGrp LOS					B						A	A
Approach Vol, veh/h					241						1356	
Approach Delay, s/veh					12.5						7.1	
Approach LOS					B						A	

Timer	1	2	3	4	5	6	7	8
Assigned Phs		2		4				
Phs Duration (G+Y+Rc), s		23.3		14.3				
Change Period (Y+Rc), s		6.0		6.0				
Max Green Setting (Gmax), s		53.0		25.0				
Max Q Clear Time (g_c+I1), s		7.3		4.2				
Green Ext Time (p_c), s		10.0		1.4				

Intersection Summary	
HCM 2010 Ctrl Delay	7.9
HCM 2010 LOS	A

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	0	375	0	0	0	0	0	816	108	0	0	0
Number	3	8	18				1	6	16			
Initial Q (Qb), veh	0	0	0				0	0	0			
Ped-Bike Adj(A_pbT)	1.00		1.00				1.00		1.00			
Parking Bus, Adj	1.00	1.00	1.00				1.00	1.00	1.00			
Adj Sat Flow, veh/h/ln	0	1810	0				0	1743	1743			
Adj Flow Rate, veh/h	0	417	0				0	907	120			
Adj No. of Lanes	0	2	0				0	3	1			
Peak Hour Factor	0.90	0.90	0.90				0.90	0.90	0.90			
Percent Heavy Veh, %	0	5	0				0	9	9			
Cap, veh/h	0	827	0				0	2065	643			
Arrive On Green	0.00	0.24	0.00				0.00	0.43	0.43			
Sat Flow, veh/h	0	3619	0				0	4916	1482			
Grp Volume(v), veh/h	0	417	0				0	907	120			
Grp Sat Flow(s),veh/h/ln	0	1719	0				0	1586	1482			
Q Serve(g_s), s	0.0	3.9	0.0				0.0	4.9	1.8			
Cycle Q Clear(g_c), s	0.0	3.9	0.0				0.0	4.9	1.8			
Prop In Lane	0.00		0.00				0.00		1.00			
Lane Grp Cap(c), veh/h	0	827	0				0	2065	643			
V/C Ratio(X)	0.00	0.50	0.00				0.00	0.44	0.19			
Avail Cap(c_a), veh/h	0	3077	0				0	5807	1808			
HCM Platoon Ratio	1.00	1.00	1.00				1.00	1.00	1.00			
Upstream Filter(I)	0.00	1.00	0.00				0.00	1.00	1.00			
Uniform Delay (d), s/veh	0.0	12.1	0.0				0.0	7.3	6.4			
Incr Delay (d2), s/veh	0.0	0.5	0.0				0.0	0.1	0.1			
Initial Q Delay(d3),s/veh	0.0	0.0	0.0				0.0	0.0	0.0			
%ile BackOfQ(50%),veh/ln	0.0	1.9	0.0				0.0	2.1	0.8			
LnGrp Delay(d),s/veh	0.0	12.6	0.0				0.0	7.4	6.6			
LnGrp LOS		B						A	A			
Approach Vol, veh/h		417						1027				
Approach Delay, s/veh		12.6						7.3				
Approach LOS		B						A				

Timer	1	2	3	4	5	6	7	8
Assigned Phs						6		8
Phs Duration (G+Y+Rc), s						22.0		14.9
Change Period (Y+Rc), s						6.0		6.0
Max Green Setting (Gmax), s						45.0		33.0
Max Q Clear Time (g_c+I1), s						6.9		5.9
Green Ext Time (p_c), s						7.3		2.8

Intersection Summary	
HCM 2010 Ctrl Delay	8.9
HCM 2010 LOS	A

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	0	254	0	0	0	0	0	1412	192	0	0	0
Number	3	8	18				1	6	16			
Initial Q (Qb), veh	0	0	0				0	0	0			
Ped-Bike Adj(A_pbT)	1.00		1.00				1.00		1.00			
Parking Bus, Adj	1.00	1.00	1.00				1.00	1.00	1.00			
Adj Sat Flow, veh/h/ln	0	1810	0				0	1776	1776			
Adj Flow Rate, veh/h	0	282	0				0	1569	213			
Adj No. of Lanes	0	2	0				0	3	1			
Peak Hour Factor	0.90	0.90	0.90				0.90	0.90	0.90			
Percent Heavy Veh, %	0	5	0				0	7	7			
Cap, veh/h	0	609	0				0	2821	878			
Arrive On Green	0.00	0.18	0.00				0.00	0.58	0.58			
Sat Flow, veh/h	0	3619	0				0	5007	1509			
Grp Volume(v), veh/h	0	282	0				0	1569	213			
Grp Sat Flow(s),veh/h/ln	0	1719	0				0	1616	1509			
Q Serve(g_s), s	0.0	3.7	0.0				0.0	10.0	3.4			
Cycle Q Clear(g_c), s	0.0	3.7	0.0				0.0	10.0	3.4			
Prop In Lane	0.00		0.00				0.00		1.00			
Lane Grp Cap(c), veh/h	0	609	0				0	2821	878			
V/C Ratio(X)	0.00	0.46	0.00				0.00	0.56	0.24			
Avail Cap(c_a), veh/h	0	1381	0				0	5648	1758			
HCM Platoon Ratio	1.00	1.00	1.00				1.00	1.00	1.00			
Upstream Filter(I)	0.00	1.00	0.00				0.00	1.00	1.00			
Uniform Delay (d), s/veh	0.0	18.4	0.0				0.0	6.4	5.1			
Incr Delay (d2), s/veh	0.0	0.5	0.0				0.0	0.2	0.1			
Initial Q Delay(d3),s/veh	0.0	0.0	0.0				0.0	0.0	0.0			
%ile BackOfQ(50%),veh/ln	0.0	1.8	0.0				0.0	4.4	1.5			
LnGrp Delay(d),s/veh	0.0	18.9	0.0				0.0	6.6	5.2			
LnGrp LOS		B						A	A			
Approach Vol, veh/h		282						1782				
Approach Delay, s/veh		18.9						6.4				
Approach LOS		B						A				

Timer	1	2	3	4	5	6	7	8
Assigned Phs						6		8
Phs Duration (G+Y+Rc), s						35.0		14.8
Change Period (Y+Rc), s						6.0		6.0
Max Green Setting (Gmax), s						58.0		20.0
Max Q Clear Time (g_c+I1), s						12.0		5.7
Green Ext Time (p_c), s						17.0		1.4

Intersection Summary	
HCM 2010 Ctrl Delay	8.1
HCM 2010 LOS	A

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	0	140	46	0	0	0	42	0	0	0	1258	422
Number	7	4	14	3	8	18	1	6	16	5	2	12
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	0	1863	1863	0	1863	0	1712	0	0	0	1743	1743
Adj Flow Rate, veh/h	0	156	51	0	0	0	47	0	0	0	1398	469
Adj No. of Lanes	0	1	1	0	1	0	1	0	0	0	3	1
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Percent Heavy Veh, %	0	2	2	0	2	0	11	0	0	0	9	9
Cap, veh/h	0	212	181	0	212	0	101	0	0	0	3524	1097
Arrive On Green	0.00	0.11	0.11	0.00	0.00	0.00	0.06	0.00	0.00	0.00	0.74	0.74
Sat Flow, veh/h	0	1863	1583	0	1863	0	1630	47		0	4916	1482
Grp Volume(v), veh/h	0	156	51	0	0	0	47	53.7		0	1398	469
Grp Sat Flow(s),veh/h/ln	0	1863	1583	0	1863	0	1630	D		0	1586	1482
Q Serve(g_s), s	0.0	9.0	3.3	0.0	0.0	0.0	3.1			0.0	12.0	13.4
Cycle Q Clear(g_c), s	0.0	9.0	3.3	0.0	0.0	0.0	3.1			0.0	12.0	13.4
Prop In Lane	0.00		1.00	0.00		0.00	1.00			0.00		1.00
Lane Grp Cap(c), veh/h	0	212	181	0	212	0	101			0	3524	1097
V/C Ratio(X)	0.00	0.73	0.28	0.00	0.00	0.00	0.47			0.00	0.40	0.43
Avail Cap(c_a), veh/h	0	402	341	0	402	0	190			0	3524	1097
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00			1.00	1.00	1.00
Upstream Filter(I)	0.00	1.00	1.00	0.00	0.00	0.00	1.00			0.00	1.00	1.00
Uniform Delay (d), s/veh	0.0	47.7	45.1	0.0	0.0	0.0	50.4			0.0	5.3	5.5
Incr Delay (d2), s/veh	0.0	4.9	0.8	0.0	0.0	0.0	3.3			0.0	0.3	1.2
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0			0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	0.0	4.9	1.5	0.0	0.0	0.0	1.5			0.0	5.3	5.7
LnGrp Delay(d),s/veh	0.0	52.5	46.0	0.0	0.0	0.0	53.7			0.0	5.6	6.7
LnGrp LOS		D	D				D				A	A
Approach Vol, veh/h		207			0						1867	
Approach Delay, s/veh		50.9			0.0						5.9	
Approach LOS		D									A	

Timer	1	2	3	4	5	6	7	8
Assigned Phs	1	2		4				8
Phs Duration (G+Y+Rc), s	12.9	88.4		18.7				18.7
Change Period (Y+Rc), s	6.0	6.0		6.0				6.0
Max Green Setting (Gmax), s	13.0	65.0		24.0				24.0
Max Q Clear Time (g_c+I1), s	5.1	15.4		12.0				0.0
Green Ext Time (p_c), s	0.0	16.9		0.7				0.0

Intersection Summary	
HCM 2010 Ctrl Delay	11.4
HCM 2010 LOS	B

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	0	316	62	0	0	0	56	0	0	0	827	203
Number	7	4	14	3	8	18	1	6	16	5	2	12
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	0	1863	1863	0	1863	0	1743	0	0	0	1776	1776
Adj Flow Rate, veh/h	0	351	69	0	0	0	62	0	0	0	919	226
Adj No. of Lanes	0	1	1	0	1	0	1	0	0	0	3	1
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Percent Heavy Veh, %	0	2	2	0	2	0	9	0	0	0	7	7
Cap, veh/h	0	426	362	0	426	0	118	0	0	0	3215	1001
Arrive On Green	0.00	0.23	0.23	0.00	0.00	0.00	0.07	0.00	0.00	0.00	0.66	0.66
Sat Flow, veh/h	0	1863	1583	0	1863	0	1660	62		0	5007	1509
Grp Volume(v), veh/h	0	351	69	0	0	0	62	51.0		0	919	226
Grp Sat Flow(s),veh/h/ln	0	1863	1583	0	1863	0	1660	D		0	1616	1509
Q Serve(g_s), s	0.0	19.0	3.7	0.0	0.0	0.0	3.8			0.0	8.3	6.3
Cycle Q Clear(g_c), s	0.0	19.0	3.7	0.0	0.0	0.0	3.8			0.0	8.3	6.3
Prop In Lane	0.00		1.00	0.00		0.00	1.00			0.00		1.00
Lane Grp Cap(c), veh/h	0	426	362	0	426	0	118			0	3215	1001
V/C Ratio(X)	0.00	0.82	0.19	0.00	0.00	0.00	0.52			0.00	0.29	0.23
Avail Cap(c_a), veh/h	0	809	688	0	809	0	219			0	3215	1001
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00			1.00	1.00	1.00
Upstream Filter(I)	0.00	1.00	1.00	0.00	0.00	0.00	1.00			0.00	1.00	1.00
Uniform Delay (d), s/veh	0.0	38.8	32.9	0.0	0.0	0.0	47.4			0.0	7.4	7.1
Incr Delay (d2), s/veh	0.0	4.0	0.3	0.0	0.0	0.0	3.6			0.0	0.2	0.5
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0			0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	0.0	10.2	1.7	0.0	0.0	0.0	1.9			0.0	3.7	2.7
LnGrp Delay(d),s/veh	0.0	42.8	33.2	0.0	0.0	0.0	51.0			0.0	7.6	7.6
LnGrp LOS		D	C				D				A	A
Approach Vol, veh/h		420			0						1145	
Approach Delay, s/veh		41.3			0.0						7.6	
Approach LOS		D									A	

Timer	1	2	3	4	5	6	7	8
Assigned Phs	1	2		4				8
Phs Duration (G+Y+Rc), s	13.5	76.2		30.2				30.2
Change Period (Y+Rc), s	6.0	6.0		6.0				6.0
Max Green Setting (Gmax), s	14.0	42.0		46.0				46.0
Max Q Clear Time (g_c+I1), s	5.8	10.3		22.0				0.0
Green Ext Time (p_c), s	0.1	7.7		2.3				0.0

Intersection Summary	
HCM 2010 Ctrl Delay	18.0
HCM 2010 LOS	B

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	0	0	0	0	15	215	0	541	81	81	0	0
Number	7	4	14	3	8	18	1	6	16	5	2	12
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	0	1863	0	0	1727	1727	0	1712	1900	1712	0	0
Adj Flow Rate, veh/h	0	0	0	0	17	239	0	601	90	90	0	0
Adj No. of Lanes	0	1	0	0	1	1	0	3	0	1	0	0
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Percent Heavy Veh, %	0	2	0	0	10	10	0	11	11	11	0	0
Cap, veh/h	0	210	0	0	195	994	0	2320	343	159	0	0
Arrive On Green	0.00	0.00	0.00	0.00	0.11	0.11	0.00	0.56	0.56	0.10	0.00	0.00
Sat Flow, veh/h	0	1863	0	0	1727	1468	0	4266	608	1630	90	
Grp Volume(v), veh/h	0	0	0	0	17	239	0	453	238	90	37.5	
Grp Sat Flow(s),veh/h/ln	0	1863	0	0	1727	1468	0	1558	1604	1630	D	
Q Serve(g_s), s	0.0	0.0	0.0	0.0	0.7	5.0	0.0	5.9	6.0	4.2		
Cycle Q Clear(g_c), s	0.0	0.0	0.0	0.0	0.7	5.0	0.0	5.9	6.0	4.2		
Prop In Lane	0.00		0.00	0.00		1.00	0.00		0.38	1.00		
Lane Grp Cap(c), veh/h	0	210	0	0	195	994	0	1757	905	159		
V/C Ratio(X)	0.00	0.00	0.00	0.00	0.09	0.24	0.00	0.26	0.26	0.57		
Avail Cap(c_a), veh/h	0	560	0	0	520	1270	0	1757	905	674		
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00		
Upstream Filter(I)	0.00	0.00	0.00	0.00	1.00	1.00	0.00	1.00	1.00	1.00		
Uniform Delay (d), s/veh	0.0	0.0	0.0	0.0	31.7	5.0	0.0	8.9	8.9	34.4		
Incr Delay (d2), s/veh	0.0	0.0	0.0	0.0	0.2	0.1	0.0	0.4	0.7	3.1		
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		
%ile BackOfQ(50%),veh/ln	0.0	0.0	0.0	0.0	0.3	5.2	0.0	2.6	2.8	2.0		
LnGrp Delay(d),s/veh	0.0	0.0	0.0	0.0	31.9	5.1	0.0	9.2	9.6	37.5		
LnGrp LOS					C	A		A	A	D		
Approach Vol, veh/h		0			256			691				
Approach Delay, s/veh		0.0			6.9			9.4				
Approach LOS					A			A				

Timer	1	2	3	4	5	6	7	8
Assigned Phs				4	5	6		8
Phs Duration (G+Y+Rc), s				15.0	13.8	51.0		15.0
Change Period (Y+Rc), s				6.0	6.0	6.0		6.0
Max Green Setting (Gmax), s				24.0	33.0	45.0		24.0
Max Q Clear Time (g_c+I1), s				0.0	6.2	8.0		7.0
Green Ext Time (p_c), s				0.0	0.2	4.5		0.8

Intersection Summary	
HCM 2010 Ctrl Delay	11.2
HCM 2010 LOS	B

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	0	0	0	0	4	262	0	1084	103	38	0	0
Number	7	4	14	3	8	18	1	6	16	5	2	12
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	0	1863	0	0	1743	1743	0	1743	1900	1743	0	0
Adj Flow Rate, veh/h	0	0	0	0	4	291	0	1204	114	42	0	0
Adj No. of Lanes	0	1	0	0	1	1	0	3	0	1	0	0
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Percent Heavy Veh, %	0	2	0	0	9	9	0	9	9	9	0	0
Cap, veh/h	0	189	0	0	177	1084	0	2789	264	109	0	0
Arrive On Green	0.00	0.00	0.00	0.00	0.10	0.10	0.00	0.63	0.63	0.07	0.00	0.00
Sat Flow, veh/h	0	1863	0	0	1743	1482	0	4580	419	1660	42	
Grp Volume(v), veh/h	0	0	0	0	4	291	0	863	455	42	42.0	
Grp Sat Flow(s),veh/h/ln	0	1863	0	0	1743	1482	0	1586	1669	1660	D	
Q Serve(g_s), s	0.0	0.0	0.0	0.0	0.2	5.8	0.0	12.3	12.3	2.2		
Cycle Q Clear(g_c), s	0.0	0.0	0.0	0.0	0.2	5.8	0.0	12.3	12.3	2.2		
Prop In Lane	0.00		0.00	0.00		1.00	0.00		0.25	1.00		
Lane Grp Cap(c), veh/h	0	189	0	0	177	1084	0	2001	1053	109		
V/C Ratio(X)	0.00	0.00	0.00	0.00	0.02	0.27	0.00	0.43	0.43	0.39		
Avail Cap(c_a), veh/h	0	378	0	0	353	1235	0	2001	1053	523		
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00		
Upstream Filter(I)	0.00	0.00	0.00	0.00	1.00	1.00	0.00	1.00	1.00	1.00		
Uniform Delay (d), s/veh	0.0	0.0	0.0	0.0	35.9	4.0	0.0	8.3	8.3	39.8		
Incr Delay (d2), s/veh	0.0	0.0	0.0	0.0	0.1	0.1	0.0	0.7	1.3	2.2		
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		
%ile BackOfQ(50%),veh/ln	0.0	0.0	0.0	0.0	0.1	7.1	0.0	5.5	5.9	1.1		
LnGrp Delay(d),s/veh	0.0	0.0	0.0	0.0	36.0	4.1	0.0	9.0	9.6	42.0		
LnGrp LOS					D	A		A	A	D		
Approach Vol, veh/h		0			295			1318				
Approach Delay, s/veh		0.0			4.5			9.2				
Approach LOS					A			A				

Timer	1	2	3	4	5	6	7	8
Assigned Phs				4	5	6		8
Phs Duration (G+Y+Rc), s				15.0	11.8	62.0		15.0
Change Period (Y+Rc), s				6.0	6.0	6.0		6.0
Max Green Setting (Gmax), s				18.0	28.0	56.0		18.0
Max Q Clear Time (g_c+I1), s				0.0	4.2	14.3		7.8
Green Ext Time (p_c), s				0.0	0.1	10.7		0.8

Intersection Summary	
HCM 2010 Ctrl Delay	9.2
HCM 2010 LOS	A

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	0	0	0	0	182	63	0	595	50	119	0	0
Number	7	4	14	3	8	18	1	6	16	5	2	12
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	0	1863	0	0	1792	1792	0	1712	1712	1712	0	0
Adj Flow Rate, veh/h	0	0	0	0	202	70	0	661	56	132	0	0
Adj No. of Lanes	0	1	0	0	1	1	0	3	1	1	0	0
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Percent Heavy Veh, %	0	2	0	0	6	6	0	11	11	11	0	0
Cap, veh/h	0	282	0	0	271	1008	0	2386	743	177	0	0
Arrive On Green	0.00	0.00	0.00	0.00	0.15	0.15	0.00	0.51	0.51	0.11	0.00	0.00
Sat Flow, veh/h	0	1863	0	0	1792	1524	0	4827	1455	1630	132	
Grp Volume(v), veh/h	0	0	0	0	202	70	0	661	56	132	40.1	
Grp Sat Flow(s),veh/h/ln	0	1863	0	0	1792	1524	0	1558	1455	1630	D	
Q Serve(g_s), s	0.0	0.0	0.0	0.0	8.4	1.3	0.0	6.3	1.5	6.2		
Cycle Q Clear(g_c), s	0.0	0.0	0.0	0.0	8.4	1.3	0.0	6.3	1.5	6.2		
Prop In Lane	0.00		0.00	0.00		1.00	0.00		1.00	1.00		
Lane Grp Cap(c), veh/h	0	282	0	0	271	1008	0	2386	743	177		
V/C Ratio(X)	0.00	0.00	0.00	0.00	0.74	0.07	0.00	0.28	0.08	0.75		
Avail Cap(c_a), veh/h	0	832	0	0	801	1459	0	2386	743	562		
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00		
Upstream Filter(I)	0.00	0.00	0.00	0.00	0.99	0.99	0.00	1.00	1.00	1.00		
Uniform Delay (d), s/veh	0.0	0.0	0.0	0.0	31.8	4.7	0.0	10.9	9.8	33.9		
Incr Delay (d2), s/veh	0.0	0.0	0.0	0.0	4.0	0.0	0.0	0.3	0.2	6.2		
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		
%ile BackOfQ(50%),veh/ln	0.0	0.0	0.0	0.0	4.5	1.3	0.0	2.8	0.6	3.1		
LnGrp Delay(d),s/veh	0.0	0.0	0.0	0.0	35.8	4.7	0.0	11.2	10.0	40.1		
LnGrp LOS					D	A		B	A	D		
Approach Vol, veh/h		0			272			717				
Approach Delay, s/veh		0.0			27.8			11.1				
Approach LOS					C			B				

Timer	1	2	3	4	5	6	7	8
Assigned Phs				4	5	6		8
Phs Duration (G+Y+Rc), s				17.9	14.5	46.0		17.9
Change Period (Y+Rc), s				6.0	6.0	6.0		6.0
Max Green Setting (Gmax), s				35.0	27.0	40.0		35.0
Max Q Clear Time (g_c+I1), s				0.0	8.2	8.3		10.4
Green Ext Time (p_c), s				0.0	0.3	4.7		1.4

Intersection Summary	
HCM 2010 Ctrl Delay	18.6
HCM 2010 LOS	B

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	0	0	0	0	121	107	0	1062	98	93	0	0
Number	7	4	14	3	8	18	1	6	16	5	2	12
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	0	1863	0	0	1810	1810	0	1743	1743	1743	0	0
Adj Flow Rate, veh/h	0	0	0	0	134	119	0	1180	109	103	0	0
Adj No. of Lanes	0	1	0	0	1	1	0	3	1	1	0	0
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Percent Heavy Veh, %	0	2	0	0	5	5	0	9	9	9	0	0
Cap, veh/h	0	193	0	0	188	1102	0	2916	908	149	0	0
Arrive On Green	0.00	0.00	0.00	0.00	0.10	0.10	0.00	0.61	0.61	0.09	0.00	0.00
Sat Flow, veh/h	0	1863	0	0	1810	1538	0	4916	1482	1660	103	
Grp Volume(v), veh/h	0	0	0	0	134	119	0	1180	109	103	46.6	
Grp Sat Flow(s),veh/h/ln	0	1863	0	0	1810	1538	0	1586	1482	1660	D	
Q Serve(g_s), s	0.0	0.0	0.0	0.0	6.7	2.2	0.0	11.9	2.9	5.6		
Cycle Q Clear(g_c), s	0.0	0.0	0.0	0.0	6.7	2.2	0.0	11.9	2.9	5.6		
Prop In Lane	0.00		0.00	0.00		1.00	0.00		1.00	1.00		
Lane Grp Cap(c), veh/h	0	193	0	0	188	1102	0	2916	908	149		
V/C Ratio(X)	0.00	0.00	0.00	0.00	0.71	0.11	0.00	0.40	0.12	0.69		
Avail Cap(c_a), veh/h	0	481	0	0	467	1339	0	2916	908	375		
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00		
Upstream Filter(I)	0.00	0.00	0.00	0.00	0.98	0.98	0.00	1.00	1.00	1.00		
Uniform Delay (d), s/veh	0.0	0.0	0.0	0.0	40.4	4.1	0.0	9.3	7.5	41.1		
Incr Delay (d2), s/veh	0.0	0.0	0.0	0.0	4.9	0.0	0.0	0.4	0.3	5.6		
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		
%ile BackOfQ(50%),veh/ln	0.0	0.0	0.0	0.0	3.6	3.0	0.0	5.2	1.2	2.8		
LnGrp Delay(d),s/veh	0.0	0.0	0.0	0.0	45.3	4.1	0.0	9.7	7.8	46.6		
LnGrp LOS					D	A		A	A	D		
Approach Vol, veh/h		0			253			1289				
Approach Delay, s/veh		0.0			25.9			9.5				
Approach LOS					C			A				

Timer	1	2	3	4	5	6	7	8
Assigned Phs				4	5	6		8
Phs Duration (G+Y+Rc), s				15.6	14.4	63.0		15.6
Change Period (Y+Rc), s				6.0	6.0	6.0		6.0
Max Green Setting (Gmax), s				24.0	21.0	57.0		24.0
Max Q Clear Time (g_c+I1), s				0.0	7.6	13.9		8.7
Green Ext Time (p_c), s				0.0	0.2	10.5		1.0

Intersection Summary	
HCM 2010 Ctrl Delay	14.4
HCM 2010 LOS	B

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Volume (veh/h)	94	16	43	577	962	183
Number	3	18	1	6	2	12
Initial Q (Qb), veh	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00	1.00	1.00			1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1407	1407	1810	1810	1712	1712
Adj Flow Rate, veh/h	104	18	48	641	1069	203
Adj No. of Lanes	2	1	1	3	3	1
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90
Percent Heavy Veh, %	35	35	5	5	11	11
Cap, veh/h	352	162	389	3503	3314	1032
Arrive On Green	0.14	0.14	0.71	0.71	0.71	0.71
Sat Flow, veh/h	2600	1196	421	5103	4827	1455
Grp Volume(v), veh/h	104	18	48	641	1069	203
Grp Sat Flow(s),veh/h/ln	1300	1196	421	1647	1558	1455
Q Serve(g_s), s	2.0	0.8	2.8	2.5	4.9	2.7
Cycle Q Clear(g_c), s	2.0	0.8	7.7	2.5	4.9	2.7
Prop In Lane	1.00	1.00	1.00			1.00
Lane Grp Cap(c), veh/h	352	162	389	3503	3314	1032
V/C Ratio(X)	0.30	0.11	0.12	0.18	0.32	0.20
Avail Cap(c_a), veh/h	640	295	389	3503	3314	1032
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	0.95	0.95	1.00	1.00
Uniform Delay (d), s/veh	22.1	21.6	4.6	2.8	3.1	2.8
Incr Delay (d2), s/veh	0.5	0.3	0.6	0.1	0.3	0.4
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	0.8	0.3	0.4	1.1	2.2	1.2
LnGrp Delay(d),s/veh	22.6	21.9	5.2	2.9	3.4	3.2
LnGrp LOS	C	C	A	A	A	A
Approach Vol, veh/h	122			689	1272	
Approach Delay, s/veh	22.5			3.0	3.4	
Approach LOS	C			A	A	

Timer	1	2	3	4	5	6	7	8
Assigned Phs		2				6		8
Phs Duration (G+Y+Rc), s		46.3				46.3		13.7
Change Period (Y+Rc), s		6.0				6.0		6.0
Max Green Setting (Gmax), s		34.0				34.0		14.0
Max Q Clear Time (g_c+I1), s		6.9				9.7		4.0
Green Ext Time (p_c), s		15.1				14.2		0.2

Intersection Summary	
HCM 2010 Ctrl Delay	4.4
HCM 2010 LOS	A

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Volume (veh/h)	175	42	29	975	695	114
Number	3	18	1	6	2	12
Initial Q (Qb), veh	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00	1.00	1.00			1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1484	1484	1827	1827	1743	1743
Adj Flow Rate, veh/h	194	47	32	1083	772	127
Adj No. of Lanes	2	1	1	3	3	1
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90
Percent Heavy Veh, %	28	28	4	4	9	9
Cap, veh/h	424	195	507	3436	3278	1021
Arrive On Green	0.15	0.15	0.92	0.92	0.69	0.69
Sat Flow, veh/h	2743	1262	605	5152	4916	1482
Grp Volume(v), veh/h	194	47	32	1083	772	127
Grp Sat Flow(s),veh/h/ln	1371	1262	605	1663	1586	1482
Q Serve(g_s), s	3.7	1.9	0.5	1.5	3.4	1.7
Cycle Q Clear(g_c), s	3.7	1.9	4.0	1.5	3.4	1.7
Prop In Lane	1.00	1.00	1.00			1.00
Lane Grp Cap(c), veh/h	424	195	507	3436	3278	1021
V/C Ratio(X)	0.46	0.24	0.06	0.32	0.24	0.12
Avail Cap(c_a), veh/h	723	333	507	3436	3278	1021
HCM Platoon Ratio	1.00	1.00	1.33	1.33	1.00	1.00
Upstream Filter(I)	1.00	1.00	0.88	0.88	1.00	1.00
Uniform Delay (d), s/veh	21.9	21.1	1.2	0.8	3.3	3.0
Incr Delay (d2), s/veh	0.8	0.6	0.2	0.2	0.2	0.3
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	1.4	0.7	0.1	0.6	1.6	0.7
LnGrp Delay(d),s/veh	22.6	21.7	1.4	1.0	3.5	3.3
LnGrp LOS	C	C	A	A	A	A
Approach Vol, veh/h	241			1115	899	
Approach Delay, s/veh	22.5			1.0	3.4	
Approach LOS	C			A	A	

Timer	1	2	3	4	5	6	7	8
Assigned Phs		2				6		8
Phs Duration (G+Y+Rc), s		45.2				45.2		14.8
Change Period (Y+Rc), s		6.0				6.0		6.0
Max Green Setting (Gmax), s		33.0				33.0		15.0
Max Q Clear Time (g_c+I1), s		5.4				6.0		5.7
Green Ext Time (p_c), s		15.6				15.4		0.6

Intersection Summary	
HCM 2010 Ctrl Delay	4.3
HCM 2010 LOS	A

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	71	63	5	119	85	134	17	447	179	169	658	155
Number	3	8	18	7	4	14	1	6	16	5	2	12
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1743	1743	1900	1845	1845	1845	1900	1845	1900	1810	1810	1810
Adj Flow Rate, veh/h	79	70	6	132	94	149	19	497	199	188	731	172
Adj No. of Lanes	1	1	0	1	1	1	0	3	0	1	2	1
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Percent Heavy Veh, %	9	9	9	3	3	3	3	3	3	5	5	5
Cap, veh/h	287	425	36	249	262	223	76	1850	713	546	2374	1175
Arrive On Green	0.07	0.27	0.27	0.14	0.14	0.14	0.56	0.56	0.56	0.16	1.00	1.00
Sat Flow, veh/h	1660	1583	136	1305	1845	1568	74	3320	1280	1723	3438	1538
Grp Volume(v), veh/h	79	0	76	132	94	149	260	229	226	188	731	172
Grp Sat Flow(s),veh/h/ln	1660	0	1719	1305	1845	1568	1694	1528	1453	1723	1719	1538
Q Serve(g_s), s	4.3	0.0	3.8	10.9	5.2	10.1	0.0	8.8	9.2	5.0	0.0	0.0
Cycle Q Clear(g_c), s	4.3	0.0	3.8	10.9	5.2	10.1	8.2	8.8	9.2	5.0	0.0	0.0
Prop In Lane	1.00		0.08	1.00		1.00	0.07		0.88	1.00		1.00
Lane Grp Cap(c), veh/h	287	0	462	249	262	223	978	851	810	546	2374	1175
V/C Ratio(X)	0.28	0.00	0.16	0.53	0.36	0.67	0.27	0.27	0.28	0.34	0.31	0.15
Avail Cap(c_a), veh/h	313	0	687	400	475	404	978	851	810	654	2374	1175
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	2.00	2.00	2.00
Upstream Filter(I)	1.00	0.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.96	0.96	0.96
Uniform Delay (d), s/veh	35.0	0.0	31.5	46.1	43.7	45.8	12.8	13.0	13.1	7.6	0.0	0.0
Incr Delay (d2), s/veh	0.5	0.0	0.2	1.7	0.8	3.4	0.7	0.8	0.9	0.4	0.3	0.3
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	2.0	0.0	1.8	4.0	2.7	4.6	4.3	3.9	3.8	2.3	0.1	0.1
LnGrp Delay(d),s/veh	35.5	0.0	31.7	47.8	44.5	49.2	13.5	13.8	13.9	7.9	0.3	0.3
LnGrp LOS	D		C	D	D	D	B	B	B	A	A	A
Approach Vol, veh/h		155			375			715			1091	
Approach Delay, s/veh		33.7			47.6			13.7			1.6	
Approach LOS		C			D			B			A	

Timer	1	2	3	4	5	6	7	8
Assigned Phs		2	3	4	5	6		8
Phs Duration (G+Y+Rc), s		83.8	14.2	22.0	15.0	68.8		36.2
Change Period (Y+Rc), s		6.0	6.0	6.0	6.0	6.0		6.0
Max Green Setting (Gmax), s		63.0	10.0	29.0	16.0	41.0		45.0
Max Q Clear Time (g_c+I1), s		2.0	6.3	12.9	7.0	11.2		5.8
Green Ext Time (p_c), s		14.9	0.0	1.6	0.3	12.4		1.9

Intersection Summary	
HCM 2010 Ctrl Delay	14.8
HCM 2010 LOS	B

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	113	116	5	114	55	152	4	753	205	131	460	119
Number	3	8	18	7	4	14	1	6	16	5	2	12
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1776	1776	1900	1863	1863	1863	1900	1863	1900	1827	1827	1827
Adj Flow Rate, veh/h	126	129	6	127	61	169	4	837	228	146	511	132
Adj No. of Lanes	1	1	0	1	1	1	0	3	0	1	2	1
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Percent Heavy Veh, %	7	7	7	2	2	2	2	2	2	4	4	4
Cap, veh/h	316	455	21	238	260	221	34	2096	565	414	2337	1167
Arrive On Green	0.08	0.27	0.27	0.14	0.14	0.14	0.54	0.54	0.54	0.16	1.00	1.00
Sat Flow, veh/h	1691	1684	78	1249	1863	1583	4	3865	1042	1740	3471	1553
Grp Volume(v), veh/h	126	0	135	127	61	169	403	335	331	146	511	132
Grp Sat Flow(s),veh/h/ln	1691	0	1762	1249	1863	1583	1857	1543	1511	1740	1736	1553
Q Serve(g_s), s	7.0	0.0	6.9	11.1	3.3	11.8	0.0	14.5	14.7	3.8	0.0	0.0
Cycle Q Clear(g_c), s	7.0	0.0	6.9	11.1	3.3	11.8	14.5	14.5	14.7	3.8	0.0	0.0
Prop In Lane	1.00		0.04	1.00		1.00	0.01		0.69	1.00		1.00
Lane Grp Cap(c), veh/h	316	0	476	238	260	221	1039	836	819	414	2337	1167
V/C Ratio(X)	0.40	0.00	0.28	0.53	0.23	0.76	0.39	0.40	0.40	0.35	0.22	0.11
Avail Cap(c_a), veh/h	346	0	646	336	407	346	1039	836	819	475	2337	1167
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	2.00	2.00	2.00
Upstream Filter(I)	1.00	0.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.98	0.98	0.98
Uniform Delay (d), s/veh	36.3	0.0	33.0	47.1	43.8	47.4	15.3	15.3	15.4	9.0	0.0	0.0
Incr Delay (d2), s/veh	0.8	0.0	0.3	1.9	0.5	5.4	1.1	1.4	1.5	0.5	0.2	0.2
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	3.3	0.0	3.4	4.0	1.7	5.5	7.7	6.5	6.4	1.8	0.1	0.1
LnGrp Delay(d),s/veh	37.1	0.0	33.3	49.0	44.2	52.8	16.4	16.7	16.8	9.5	0.2	0.2
LnGrp LOS	D		C	D	D	D	B	B	B	A	A	A
Approach Vol, veh/h		261			357			1069			789	
Approach Delay, s/veh		35.2			50.0			16.6			1.9	
Approach LOS		D			D			B			A	

Timer	1	2	3	4	5	6	7	8
Assigned Phs		2	3	4	5	6		8
Phs Duration (G+Y+Rc), s		83.1	14.9	22.0	15.0	68.1		36.9
Change Period (Y+Rc), s		6.0	6.0	6.0	6.0	6.0		6.0
Max Green Setting (Gmax), s		66.0	11.0	25.0	13.0	47.0		42.0
Max Q Clear Time (g_c+I1), s		2.0	9.0	13.8	5.8	16.7		8.9
Green Ext Time (p_c), s		16.1	0.1	1.6	0.2	13.2		2.1

Intersection Summary	
HCM 2010 Ctrl Delay	18.7
HCM 2010 LOS	B

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	5	10	22	80	14	17	14	629	34	20	785	8
Number	3	8	18	7	4	14	1	6	16	5	2	12
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1900	1863	1900	1900	1863	1900	1845	1845	1900	1845	1845	1900
Adj Flow Rate, veh/h	6	11	24	89	16	19	16	699	38	22	872	9
Adj No. of Lanes	0	1	0	0	1	0	1	2	0	1	2	0
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Percent Heavy Veh, %	2	2	2	2	2	2	3	3	3	3	3	3
Cap, veh/h	108	161	269	391	72	63	342	1669	91	394	1754	18
Arrive On Green	0.28	0.28	0.28	0.28	0.28	0.28	0.49	0.49	0.49	0.49	0.49	0.49
Sat Flow, veh/h	107	579	968	986	260	225	621	3381	184	711	3554	37
Grp Volume(v), veh/h	41	0	0	124	0	0	16	362	375	22	430	451
Grp Sat Flow(s),veh/h/ln	1653	0	0	1471	0	0	621	1752	1812	711	1752	1838
Q Serve(g_s), s	0.0	0.0	0.0	2.3	0.0	0.0	0.9	6.9	6.9	1.1	8.6	8.6
Cycle Q Clear(g_c), s	0.9	0.0	0.0	3.3	0.0	0.0	9.6	6.9	6.9	8.0	8.6	8.6
Prop In Lane	0.15		0.59	0.72		0.15	1.00		0.10	1.00		0.02
Lane Grp Cap(c), veh/h	538	0	0	526	0	0	342	865	895	394	865	907
V/C Ratio(X)	0.08	0.00	0.00	0.24	0.00	0.00	0.05	0.42	0.42	0.06	0.50	0.50
Avail Cap(c_a), veh/h	889	0	0	842	0	0	651	1738	1797	748	1738	1823
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	0.00	0.00	1.00	0.00	0.00	1.00	1.00	1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	14.0	0.0	0.0	14.8	0.0	0.0	12.1	8.5	8.5	11.0	8.9	8.9
Incr Delay (d2), s/veh	0.1	0.0	0.0	0.2	0.0	0.0	0.1	0.3	0.3	0.1	0.4	0.4
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	0.4	0.0	0.0	1.4	0.0	0.0	0.2	3.4	3.5	0.2	4.2	4.4
LnGrp Delay(d),s/veh	14.1	0.0	0.0	15.0	0.0	0.0	12.2	8.8	8.8	11.1	9.4	9.3
LnGrp LOS	B			B			B	A	A	B	A	A
Approach Vol, veh/h		41			124			753			903	
Approach Delay, s/veh		14.1			15.0			8.9			9.4	
Approach LOS		B			B			A			A	

Timer	1	2	3	4	5	6	7	8
Assigned Phs		2		4		6		8
Phs Duration (G+Y+Rc), s		31.9		20.6		31.9		20.6
Change Period (Y+Rc), s		6.0		6.0		6.0		6.0
Max Green Setting (Gmax), s		52.0		26.0		52.0		26.0
Max Q Clear Time (g_c+I1), s		10.6		5.3		11.6		2.9
Green Ext Time (p_c), s		14.4		0.9		14.3		0.9

Intersection Summary	
HCM 2010 Ctrl Delay	9.7
HCM 2010 LOS	A

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	5	8	14	52	18	29	21	930	60	19	578	8
Number	3	8	18	7	4	14	1	6	16	5	2	12
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1900	1863	1900	1900	1863	1900	1845	1845	1900	1863	1863	1900
Adj Flow Rate, veh/h	6	9	16	58	20	32	23	1033	67	21	642	9
Adj No. of Lanes	0	1	0	0	1	0	1	2	0	1	2	0
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Percent Heavy Veh, %	2	2	2	2	2	2	3	3	3	2	2	2
Cap, veh/h	115	155	209	266	98	110	469	1832	119	300	1959	27
Arrive On Green	0.25	0.25	0.25	0.25	0.25	0.25	0.55	0.55	0.55	0.55	0.55	0.55
Sat Flow, veh/h	168	629	851	696	396	448	770	3342	217	510	3573	50
Grp Volume(v), veh/h	31	0	0	110	0	0	23	542	558	21	318	333
Grp Sat Flow(s),veh/h/ln	1648	0	0	1540	0	0	770	1752	1806	510	1770	1854
Q Serve(g_s), s	0.0	0.0	0.0	1.3	0.0	0.0	1.0	11.8	11.8	1.6	5.8	5.8
Cycle Q Clear(g_c), s	0.8	0.0	0.0	3.1	0.0	0.0	6.8	11.8	11.8	13.4	5.8	5.8
Prop In Lane	0.19		0.52	0.53		0.29	1.00		0.12	1.00		0.03
Lane Grp Cap(c), veh/h	479	0	0	473	0	0	469	961	990	300	970	1016
V/C Ratio(X)	0.06	0.00	0.00	0.23	0.00	0.00	0.05	0.56	0.56	0.07	0.33	0.33
Avail Cap(c_a), veh/h	688	0	0	670	0	0	786	1681	1733	510	1698	1778
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	0.00	0.00	1.00	0.00	0.00	1.00	1.00	1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	16.9	0.0	0.0	17.7	0.0	0.0	9.1	8.6	8.6	13.0	7.3	7.3
Incr Delay (d2), s/veh	0.1	0.0	0.0	0.2	0.0	0.0	0.0	0.5	0.5	0.1	0.2	0.2
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	0.4	0.0	0.0	1.5	0.0	0.0	0.2	5.7	5.9	0.2	2.8	2.9
LnGrp Delay(d),s/veh	16.9	0.0	0.0	18.0	0.0	0.0	9.2	9.1	9.1	13.1	7.5	7.4
LnGrp LOS	B			B			A	A	A	B	A	A
Approach Vol, veh/h		31			110			1123			672	
Approach Delay, s/veh		16.9			18.0			9.1			7.6	
Approach LOS		B			B			A			A	

Timer	1	2	3	4	5	6	7	8
Assigned Phs		2		4		6		8
Phs Duration (G+Y+Rc), s		38.0		20.4		38.0		20.4
Change Period (Y+Rc), s		6.0		6.0		6.0		6.0
Max Green Setting (Gmax), s		56.0		22.0		56.0		22.0
Max Q Clear Time (g_c+I1), s		15.4		5.1		13.8		2.8
Green Ext Time (p_c), s		16.6		0.7		16.8		0.7

Intersection Summary	
HCM 2010 Ctrl Delay	9.2
HCM 2010 LOS	A

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	38	55	10	125	80	138	8	539	271	212	726	47
Number	3	8	18	7	4	14	1	6	16	5	2	12
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1900	1759	1900	1900	1827	1827	1845	1845	1845	1845	1845	1845
Adj Flow Rate, veh/h	42	61	11	139	89	153	9	599	301	236	807	52
Adj No. of Lanes	0	2	0	0	1	1	1	2	1	1	2	1
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Percent Heavy Veh, %	8	8	8	4	4	4	3	3	3	3	3	3
Cap, veh/h	134	330	60	238	123	388	426	2035	911	540	2459	1100
Arrive On Green	0.25	0.25	0.25	0.25	0.25	0.25	1.00	1.00	1.00	0.07	0.70	0.70
Sat Flow, veh/h	304	1321	238	764	493	1553	634	3505	1568	1757	3505	1568
Grp Volume(v), veh/h	42	0	72	228	0	153	9	599	301	236	807	52
Grp Sat Flow(s),veh/h/ln	304	0	1559	1257	0	1553	634	1752	1568	1757	1752	1568
Q Serve(g_s), s	4.7	0.0	4.5	17.9	0.0	10.2	0.0	0.0	0.0	6.4	11.1	1.3
Cycle Q Clear(g_c), s	26.9	0.0	4.5	22.3	0.0	10.2	0.1	0.0	0.0	6.4	11.1	1.3
Prop In Lane	1.00		0.15	0.61		1.00	1.00		1.00	1.00		1.00
Lane Grp Cap(c), veh/h	134	0	390	361	0	388	426	2035	911	540	2459	1100
V/C Ratio(X)	0.31	0.00	0.18	0.63	0.00	0.39	0.02	0.29	0.33	0.44	0.33	0.05
Avail Cap(c_a), veh/h	238	0	541	503	0	539	426	2035	911	752	2459	1100
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	2.00	2.00	2.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	0.00	1.00	0.99	0.00	0.99	0.94	0.94	0.94	0.88	0.88	0.88
Uniform Delay (d), s/veh	55.7	0.0	36.6	45.3	0.0	38.7	0.0	0.0	0.0	7.9	7.2	5.7
Incr Delay (d2), s/veh	1.3	0.0	0.2	1.8	0.0	0.6	0.1	0.3	0.9	0.5	0.3	0.1
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	1.4	0.0	2.0	7.5	0.0	4.4	0.0	0.1	0.2	3.1	5.4	0.6
LnGrp Delay(d),s/veh	57.0	0.0	36.8	47.1	0.0	39.3	0.1	0.3	0.9	8.3	7.5	5.8
LnGrp LOS	E		D	D		D	A	A	A	A	A	A
Approach Vol, veh/h		114			381			909			1095	
Approach Delay, s/veh		44.2			44.0			0.5			7.6	
Approach LOS		D			D			A			A	

Timer	1	2	3	4	5	6	7	8
Assigned Phs		2		4	5	6		8
Phs Duration (G+Y+Rc), s		93.0		37.0	15.0	78.0		37.0
Change Period (Y+Rc), s		6.0		6.0	6.0	6.0		6.0
Max Green Setting (Gmax), s		75.0		43.0	24.0	45.0		43.0
Max Q Clear Time (g_c+I1), s		13.1		24.3	8.4	2.1		28.9
Green Ext Time (p_c), s		17.0		2.4	0.6	15.6		2.1

Intersection Summary	
HCM 2010 Ctrl Delay	12.2
HCM 2010 LOS	B

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	27	50	25	181	90	259	23	750	176	88	505	39
Number	3	8	18	7	4	14	1	6	16	5	2	12
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1900	1792	1900	1900	1845	1845	1845	1845	1845	1845	1845	1845
Adj Flow Rate, veh/h	30	56	28	201	100	288	26	833	196	98	561	43
Adj No. of Lanes	0	2	0	0	1	1	1	2	1	1	2	1
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Percent Heavy Veh, %	6	6	6	3	3	3	3	3	3	3	3	3
Cap, veh/h	117	315	170	307	127	471	479	1815	812	475	2264	1013
Arrive On Green	0.30	0.30	0.30	0.30	0.30	0.30	1.00	1.00	1.00	0.08	0.65	0.65
Sat Flow, veh/h	200	1049	564	847	421	1568	805	3505	1568	1757	3505	1568
Grp Volume(v), veh/h	38	0	76	301	0	288	26	833	196	98	561	43
Grp Sat Flow(s),veh/h/ln	282	0	1532	1269	0	1568	805	1752	1568	1757	1752	1568
Q Serve(g_s), s	3.0	0.0	4.2	22.2	0.0	18.0	0.0	0.0	0.0	2.6	7.7	1.1
Cycle Q Clear(g_c), s	29.1	0.0	4.2	26.2	0.0	18.0	0.1	0.0	0.0	2.6	7.7	1.1
Prop In Lane	0.79		0.37	0.67		1.00	1.00		1.00	1.00		1.00
Lane Grp Cap(c), veh/h	141	0	460	434	0	471	479	1815	812	475	2264	1013
V/C Ratio(X)	0.27	0.00	0.17	0.69	0.00	0.61	0.05	0.46	0.24	0.21	0.25	0.04
Avail Cap(c_a), veh/h	250	0	617	581	0	632	479	1815	812	496	2264	1013
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	2.00	2.00	2.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	0.00	1.00	0.93	0.00	0.93	0.90	0.90	0.90	0.96	0.96	0.96
Uniform Delay (d), s/veh	44.4	0.0	29.4	39.0	0.0	34.2	0.0	0.0	0.0	9.2	8.5	7.4
Incr Delay (d2), s/veh	1.0	0.0	0.2	2.1	0.0	1.2	0.2	0.8	0.6	0.2	0.3	0.1
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	1.2	0.0	1.8	9.0	0.0	7.9	0.0	0.2	0.1	1.3	3.8	0.5
LnGrp Delay(d),s/veh	45.4	0.0	29.5	41.0	0.0	35.4	0.2	0.8	0.6	9.4	8.8	7.4
LnGrp LOS	D		C	D		D	A	A	A	A	A	A
Approach Vol, veh/h		114			589			1055			702	
Approach Delay, s/veh		34.8			38.3			0.7			8.8	
Approach LOS		C			D			A			A	

Timer	1	2	3	4	5	6	7	8
Assigned Phs		2		4	5	6		8
Phs Duration (G+Y+Rc), s		79.7		40.3	14.6	65.1		40.3
Change Period (Y+Rc), s		6.0		6.0	6.0	6.0		6.0
Max Green Setting (Gmax), s		62.0		46.0	10.0	46.0		46.0
Max Q Clear Time (g_c+I1), s		9.7		28.2	4.6	2.1		31.1
Green Ext Time (p_c), s		15.5		3.4	0.1	14.8		3.1

Intersection Summary	
HCM 2010 Ctrl Delay	13.6
HCM 2010 LOS	B

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Volume (veh/h)	193	130	115	528	711	116
Number	3	18	1	6	2	12
Initial Q (Qb), veh	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00	1.00	1.00			1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1810	1810	1827	1827	1845	1845
Adj Flow Rate, veh/h	214	144	128	587	790	129
Adj No. of Lanes	1	1	1	2	2	1
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90
Percent Heavy Veh, %	5	5	4	4	3	3
Cap, veh/h	280	250	481	2428	2452	1097
Arrive On Green	0.16	0.16	0.93	0.93	0.70	0.70
Sat Flow, veh/h	1723	1538	594	3563	3597	1568
Grp Volume(v), veh/h	214	144	128	587	790	129
Grp Sat Flow(s),veh/h/ln	1723	1538	594	1736	1752	1568
Q Serve(g_s), s	7.3	5.3	3.5	0.9	5.4	1.7
Cycle Q Clear(g_c), s	7.3	5.3	8.8	0.9	5.4	1.7
Prop In Lane	1.00	1.00	1.00			1.00
Lane Grp Cap(c), veh/h	280	250	481	2428	2452	1097
V/C Ratio(X)	0.77	0.58	0.27	0.24	0.32	0.12
Avail Cap(c_a), veh/h	476	425	481	2428	2452	1097
HCM Platoon Ratio	1.00	1.00	1.33	1.33	1.00	1.00
Upstream Filter(I)	0.92	0.92	0.81	0.81	0.95	0.95
Uniform Delay (d), s/veh	24.6	23.8	1.6	0.7	3.6	3.0
Incr Delay (d2), s/veh	4.0	1.9	1.1	0.2	0.3	0.2
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	3.8	2.4	0.7	0.5	2.6	0.8
LnGrp Delay(d),s/veh	28.6	25.7	2.7	0.9	3.9	3.2
LnGrp LOS	C	C	A	A	A	A
Approach Vol, veh/h	358			715	919	
Approach Delay, s/veh	27.5			1.2	3.8	
Approach LOS	C			A	A	

Timer	1	2	3	4	5	6	7	8
Assigned Phs		2				6		8
Phs Duration (G+Y+Rc), s		49.0				49.0		16.0
Change Period (Y+Rc), s		6.0				6.0		6.0
Max Green Setting (Gmax), s		36.0				36.0		17.0
Max Q Clear Time (g_c+I1), s		7.4				10.8		9.3
Green Ext Time (p_c), s		13.5				12.7		0.7

Intersection Summary	
HCM 2010 Ctrl Delay	7.1
HCM 2010 LOS	A

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Volume (veh/h)	180	90	172	781	562	154
Number	3	18	1	6	2	12
Initial Q (Qb), veh	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00	1.00	1.00			1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1827	1827	1845	1845	1845	1845
Adj Flow Rate, veh/h	200	100	191	868	624	171
Adj No. of Lanes	1	1	1	2	2	1
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90
Percent Heavy Veh, %	4	4	3	3	3	3
Cap, veh/h	270	241	568	2383	2383	1066
Arrive On Green	0.16	0.16	0.90	0.90	0.90	0.90
Sat Flow, veh/h	1740	1553	673	3597	3597	1568
Grp Volume(v), veh/h	200	100	191	868	624	171
Grp Sat Flow(s),veh/h/ln	1740	1553	673	1752	1752	1568
Q Serve(g_s), s	6.3	3.3	3.3	2.0	1.3	0.7
Cycle Q Clear(g_c), s	6.3	3.3	4.6	2.0	1.3	0.7
Prop In Lane	1.00	1.00	1.00			1.00
Lane Grp Cap(c), veh/h	270	241	568	2383	2383	1066
V/C Ratio(X)	0.74	0.41	0.34	0.36	0.26	0.16
Avail Cap(c_a), veh/h	424	378	568	2383	2383	1066
HCM Platoon Ratio	1.00	1.00	1.33	1.33	1.33	1.33
Upstream Filter(I)	0.96	0.96	0.70	0.70	0.98	0.98
Uniform Delay (d), s/veh	23.2	21.9	1.2	1.0	0.9	0.9
Incr Delay (d2), s/veh	3.8	1.1	1.1	0.3	0.3	0.3
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	3.3	1.5	0.7	0.9	0.6	0.3
LnGrp Delay(d),s/veh	27.0	23.0	2.3	1.3	1.2	1.2
LnGrp LOS	C	C	A	A	A	A
Approach Vol, veh/h	300			1059	795	
Approach Delay, s/veh	25.7			1.5	1.2	
Approach LOS	C			A	A	

Timer	1	2	3	4	5	6	7	8
Assigned Phs		2				6		8
Phs Duration (G+Y+Rc), s		45.1				45.1		14.9
Change Period (Y+Rc), s		6.0				6.0		6.0
Max Green Setting (Gmax), s		34.0				34.0		14.0
Max Q Clear Time (g_c+I1), s		3.3				6.6		8.3
Green Ext Time (p_c), s		16.0				15.1		0.5

Intersection Summary	
HCM 2010 Ctrl Delay	4.7
HCM 2010 LOS	A

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	379	616	285	24	307	27	108	282	13	56	463	297
Number	3	8	18	7	4	14	1	6	16	5	2	12
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1810	1810	1900	1827	1827	1900	1792	1792	1900	1827	1827	1827
Adj Flow Rate, veh/h	421	684	317	27	341	30	120	313	14	62	514	330
Adj No. of Lanes	1	2	0	1	2	0	1	2	0	1	2	1
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Percent Heavy Veh, %	5	5	5	4	4	4	6	6	6	4	4	4
Cap, veh/h	499	984	456	148	520	45	422	1790	80	488	1447	990
Arrive On Green	0.22	0.43	0.43	0.16	0.16	0.16	0.15	1.00	1.00	0.83	0.83	0.83
Sat Flow, veh/h	1723	2284	1058	550	3230	283	1707	3321	148	1028	3471	1553
Grp Volume(v), veh/h	421	515	486	27	182	189	120	160	167	62	514	330
Grp Sat Flow(s),veh/h/ln	1723	1719	1623	550	1736	1777	1707	1703	1766	1028	1736	1553
Q Serve(g_s), s	23.7	29.6	29.6	5.3	12.0	12.1	4.5	0.0	0.0	1.4	4.3	4.7
Cycle Q Clear(g_c), s	23.7	29.6	29.6	5.3	12.0	12.1	4.5	0.0	0.0	1.4	4.3	4.7
Prop In Lane	1.00		0.65	1.00		0.16	1.00		0.08	1.00		1.00
Lane Grp Cap(c), veh/h	499	740	699	148	279	286	422	918	952	488	1447	990
V/C Ratio(X)	0.84	0.70	0.70	0.18	0.65	0.66	0.28	0.17	0.18	0.13	0.36	0.33
Avail Cap(c_a), veh/h	685	975	920	163	328	336	438	918	952	488	1447	990
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	2.00	2.00	2.00	2.00	2.00	2.00
Upstream Filter(I)	0.66	0.66	0.66	0.96	0.96	0.96	0.99	0.99	0.99	0.94	0.94	0.94
Uniform Delay (d), s/veh	30.6	28.2	28.2	45.1	47.9	47.9	14.9	0.0	0.0	6.0	6.3	2.5
Incr Delay (d2), s/veh	4.8	1.0	1.0	0.6	3.5	3.6	0.4	0.4	0.4	0.5	0.6	0.9
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	11.9	14.2	13.4	0.8	6.0	6.3	2.2	0.1	0.1	0.5	2.0	1.9
LnGrp Delay(d),s/veh	35.4	29.1	29.2	45.6	51.3	51.5	15.3	0.4	0.4	6.5	6.9	3.4
LnGrp LOS	D	C	C	D	D	D	B	A	A	A	A	A
Approach Vol, veh/h		1422			398			447			906	
Approach Delay, s/veh		31.0			51.0			4.4			5.6	
Approach LOS		C			D			A			A	

Timer	1	2	3	4	5	6	7	8
Assigned Phs	1	2	3	4		6		8
Phs Duration (G+Y+Rc), s	14.8	56.7	32.8	25.6		71.6		58.4
Change Period (Y+Rc), s	6.0	6.0	6.0	6.0		6.0		6.0
Max Green Setting (Gmax), s	10.0	33.0	40.0	23.0		49.0		69.0
Max Q Clear Time (g_c+I1), s	6.5	6.7	25.7	14.1		2.0		31.6
Green Ext Time (p_c), s	0.1	7.5	1.2	5.4		8.3		11.8

Intersection Summary	
HCM 2010 Ctrl Delay	22.5
HCM 2010 LOS	C

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	400	349	141	22	612	59	289	508	38	49	352	319
Number	3	8	18	7	4	14	1	6	16	5	2	12
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1827	1827	1900	1845	1845	1900	1827	1827	1900	1845	1845	1845
Adj Flow Rate, veh/h	444	388	157	24	680	66	321	564	42	54	391	354
Adj No. of Lanes	1	2	0	1	2	0	1	2	0	1	2	1
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Percent Heavy Veh, %	4	4	4	3	3	3	4	4	4	3	3	3
Cap, veh/h	474	1237	494	260	754	73	399	1341	100	223	706	670
Arrive On Green	0.23	0.51	0.51	0.23	0.23	0.23	0.05	0.14	0.14	0.07	0.07	0.07
Sat Flow, veh/h	1740	2424	968	850	3229	313	1740	3276	244	803	3505	1568
Grp Volume(v), veh/h	444	276	269	24	369	377	321	298	308	54	391	354
Grp Sat Flow(s),veh/h/ln	1740	1736	1656	850	1752	1789	1740	1736	1784	803	1752	1568
Q Serve(g_s), s	23.8	10.9	11.1	2.6	24.0	24.1	16.2	18.5	18.6	7.5	12.7	19.2
Cycle Q Clear(g_c), s	23.8	10.9	11.1	2.6	24.0	24.1	16.2	18.5	18.6	7.5	12.7	19.2
Prop In Lane	1.00		0.58	1.00		0.17	1.00		0.14	1.00		1.00
Lane Grp Cap(c), veh/h	474	886	845	260	409	418	399	710	730	223	706	670
V/C Ratio(X)	0.94	0.31	0.32	0.09	0.90	0.90	0.80	0.42	0.42	0.24	0.55	0.53
Avail Cap(c_a), veh/h	541	960	916	264	418	427	423	710	730	223	706	670
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	0.33	0.33	0.33	0.33	0.33	0.33
Upstream Filter(I)	0.91	0.91	0.91	0.92	0.92	0.92	0.96	0.96	0.96	0.97	0.97	0.97
Uniform Delay (d), s/veh	30.9	16.8	16.8	35.5	43.7	43.7	33.5	38.0	38.1	47.3	49.7	29.0
Incr Delay (d2), s/veh	21.2	0.2	0.2	0.1	20.6	20.5	10.0	1.8	1.7	2.5	3.0	2.9
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	16.8	5.3	5.1	0.6	13.9	14.2	8.9	9.3	9.6	1.8	6.5	8.9
LnGrp Delay(d),s/veh	52.1	16.9	17.0	35.7	64.3	64.3	43.5	39.8	39.8	49.8	52.7	31.8
LnGrp LOS	D	B	B	D	E	E	D	D	D	D	D	C
Approach Vol, veh/h		989			770			927			799	
Approach Delay, s/veh		32.7			63.4			41.1			43.3	
Approach LOS		C			E			D			D	

Timer	1	2	3	4	5	6	7	8
Assigned Phs	1	2	3	4		6		8
Phs Duration (G+Y+Rc), s	24.4	29.7	32.5	33.4		54.1		65.9
Change Period (Y+Rc), s	6.0	6.0	6.0	6.0		6.0		6.0
Max Green Setting (Gmax), s	20.0	17.0	31.0	28.0		43.0		65.0
Max Q Clear Time (g_c+I1), s	18.2	21.2	25.8	26.1		20.6		13.1
Green Ext Time (p_c), s	0.2	0.0	0.7	1.4		8.4		10.7

Intersection Summary	
HCM 2010 Ctrl Delay	44.1
HCM 2010 LOS	D

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	14	51	115	16	44	118	26	283	18	93	547	37
Number	3	8	18	7	4	14	1	6	16	5	2	12
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1900	1827	1900	1900	1776	1900	1810	1810	1900	1792	1792	1792
Adj Flow Rate, veh/h	16	57	128	18	49	131	29	314	20	103	608	41
Adj No. of Lanes	0	1	0	0	1	0	1	2	0	1	2	1
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Percent Heavy Veh, %	4	4	4	7	7	7	5	5	5	6	6	6
Cap, veh/h	45	84	168	47	73	169	625	2439	155	909	2965	1327
Arrive On Green	0.16	0.16	0.16	0.16	0.16	0.16	0.74	0.74	0.74	0.15	1.00	1.00
Sat Flow, veh/h	72	531	1058	83	460	1062	757	3284	208	1707	3406	1524
Grp Volume(v), veh/h	201	0	0	198	0	0	29	164	170	103	608	41
Grp Sat Flow(s),veh/h/ln	1662	0	0	1605	0	0	757	1719	1773	1707	1703	1524
Q Serve(g_s), s	0.0	0.0	0.0	0.3	0.0	0.0	1.2	3.1	3.1	1.2	0.0	0.0
Cycle Q Clear(g_c), s	13.0	0.0	0.0	13.3	0.0	0.0	1.2	3.1	3.1	1.2	0.0	0.0
Prop In Lane	0.08		0.64	0.09		0.66	1.00		0.12	1.00		1.00
Lane Grp Cap(c), veh/h	298	0	0	289	0	0	625	1277	1317	909	2965	1327
V/C Ratio(X)	0.67	0.00	0.00	0.68	0.00	0.00	0.05	0.13	0.13	0.11	0.21	0.03
Avail Cap(c_a), veh/h	722	0	0	698	0	0	625	1277	1317	1093	2965	1327
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	2.00	2.00	2.00
Upstream Filter(I)	1.00	0.00	0.00	0.96	0.00	0.00	1.00	1.00	1.00	0.91	0.91	0.91
Uniform Delay (d), s/veh	46.1	0.0	0.0	46.2	0.0	0.0	3.9	4.2	4.2	1.6	0.0	0.0
Incr Delay (d2), s/veh	2.7	0.0	0.0	2.8	0.0	0.0	0.1	0.2	0.2	0.0	0.1	0.0
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	6.3	0.0	0.0	6.2	0.0	0.0	0.3	1.5	1.6	0.5	0.1	0.0
LnGrp Delay(d),s/veh	48.8	0.0	0.0	49.0	0.0	0.0	4.1	4.4	4.4	1.7	0.1	0.0
LnGrp LOS	D			D			A	A	A	A	A	A
Approach Vol, veh/h		201			198			363			752	
Approach Delay, s/veh		48.8			49.0			4.4			0.3	
Approach LOS		D			D			A			A	

Timer	1	2	3	4	5	6	7	8
Assigned Phs		2		4	5	6		8
Phs Duration (G+Y+Rc), s		105.8		24.2	14.7	91.1		24.2
Change Period (Y+Rc), s		6.0		6.0	6.0	6.0		6.0
Max Green Setting (Gmax), s		69.0		49.0	21.0	42.0		49.0
Max Q Clear Time (g_c+I1), s		2.0		15.3	3.2	5.1		15.0
Green Ext Time (p_c), s		7.8		2.9	0.2	7.5		3.0

Intersection Summary	
HCM 2010 Ctrl Delay	14.1
HCM 2010 LOS	B

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	61	54	50	16	61	154	68	533	30	89	348	54
Number	3	8	18	7	4	14	1	6	16	5	2	12
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1900	1845	1900	1900	1810	1900	1827	1827	1900	1827	1827	1827
Adj Flow Rate, veh/h	68	60	56	18	68	171	76	592	33	99	387	60
Adj No. of Lanes	0	1	0	0	1	0	1	2	0	1	2	1
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Percent Heavy Veh, %	3	3	3	5	5	5	4	4	4	4	4	4
Cap, veh/h	114	98	73	47	96	214	665	2178	121	651	2719	1216
Arrive On Green	0.20	0.20	0.20	0.20	0.20	0.20	0.65	0.65	0.65	0.08	0.78	0.78
Sat Flow, veh/h	353	503	375	63	488	1096	921	3343	186	1740	3471	1553
Grp Volume(v), veh/h	184	0	0	257	0	0	76	307	318	99	387	60
Grp Sat Flow(s),veh/h/ln	1231	0	0	1646	0	0	921	1736	1794	1740	1736	1553
Q Serve(g_s), s	0.4	0.0	0.0	0.0	0.0	0.0	3.5	8.3	8.3	1.7	3.0	1.0
Cycle Q Clear(g_c), s	16.6	0.0	0.0	16.2	0.0	0.0	3.5	8.3	8.3	1.7	3.0	1.0
Prop In Lane	0.37		0.30	0.07		0.67	1.00		0.10	1.00		1.00
Lane Grp Cap(c), veh/h	286	0	0	357	0	0	665	1130	1169	651	2719	1216
V/C Ratio(X)	0.64	0.00	0.00	0.72	0.00	0.00	0.11	0.27	0.27	0.15	0.14	0.05
Avail Cap(c_a), veh/h	537	0	0	634	0	0	665	1130	1169	752	2719	1216
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	0.00	0.00	0.98	0.00	0.00	1.00	1.00	1.00	0.71	0.71	0.71
Uniform Delay (d), s/veh	41.6	0.0	0.0	42.3	0.0	0.0	7.3	8.1	8.1	4.3	2.9	2.7
Incr Delay (d2), s/veh	2.4	0.0	0.0	2.7	0.0	0.0	0.3	0.6	0.6	0.1	0.1	0.1
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	5.6	0.0	0.0	7.7	0.0	0.0	0.9	4.1	4.3	0.8	1.4	0.4
LnGrp Delay(d),s/veh	44.0	0.0	0.0	45.0	0.0	0.0	7.7	8.7	8.7	4.4	3.0	2.7
LnGrp LOS	D			D			A	A	A	A	A	A
Approach Vol, veh/h		184			257			701			546	
Approach Delay, s/veh		44.0			45.0			8.6			3.2	
Approach LOS		D			D			A			A	

Timer	1	2	3	4	5	6	7	8
Assigned Phs		2		4	5	6		8
Phs Duration (G+Y+Rc), s		92.4		27.6	14.6	77.8		27.6
Change Period (Y+Rc), s		6.0		6.0	6.0	6.0		6.0
Max Green Setting (Gmax), s		67.0		41.0	15.0	46.0		41.0
Max Q Clear Time (g_c+I1), s		5.0		18.2	3.7	10.3		18.6
Green Ext Time (p_c), s		8.7		3.1	0.2	8.2		3.0

Intersection Summary	
HCM 2010 Ctrl Delay	16.3
HCM 2010 LOS	B

Intersection	
Int Delay, s/veh	2.1

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Vol, veh/h	0	219	143	18	357	347
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	-	0	-	-	250	-
Veh in Median Storage, #	0	-	0	-	-	0
Grade, %	0	-	0	-	-	0
Peak Hour Factor	90	90	90	90	90	90
Heavy Vehicles, %	8	8	2	2	5	5
Mvmt Flow	0	243	159	20	397	386

Major/Minor	Minor1		Major1		Major2	
Conflicting Flow All	1155	89	0	0	179	0
Stage 1	169	-	-	-	-	-
Stage 2	986	-	-	-	-	-
Critical Hdwy	6.96	7.06	-	-	4.2	-
Critical Hdwy Stg 1	5.96	-	-	-	-	-
Critical Hdwy Stg 2	5.96	-	-	-	-	-
Follow-up Hdwy	3.58	3.38	-	-	2.25	-
Pot Cap-1 Maneuver	181	932	-	-	1372	-
Stage 1	826	-	-	-	-	-
Stage 2	308	-	-	-	-	-
Platoon blocked, %			-	-		-
Mov Cap-1 Maneuver	129	932	-	-	1372	-
Mov Cap-2 Maneuver	191	-	-	-	-	-
Stage 1	826	-	-	-	-	-
Stage 2	219	-	-	-	-	-

Approach	WB	NB	SB
HCM Control Delay, s	10.2		
HCM LOS	B		

Minor Lane/Major Mvmt	NBT	NBR	WBLn1	SBL	SBT
Capacity (veh/h)	-	-	932	1372	-
HCM Lane V/C Ratio	-	-	0.261	0.289	-
HCM Control Delay (s)	-	-	10.2	8.7	-
HCM Lane LOS	-	-	B	A	-
HCM 95th %tile Q(veh)	-	-	1	1	-

Intersection	
Int Delay, s/veh	4.2

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Vol, veh/h	0	337	304	28	232	149
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	-	0	-	-	250	-
Veh in Median Storage, #	0	-	0	-	-	0
Grade, %	0	-	0	-	-	0
Peak Hour Factor	90	90	90	90	90	90
Heavy Vehicles, %	7	7	2	2	4	4
Mvmt Flow	0	374	338	31	258	166

Major/Minor	Minor1		Major1		Major2	
Conflicting Flow All	951	184	0	0	369	0
Stage 1	353	-	-	-	-	-
Stage 2	598	-	-	-	-	-
Critical Hdwy	6.94	7.04	-	-	4.18	-
Critical Hdwy Stg 1	5.94	-	-	-	-	-
Critical Hdwy Stg 2	5.94	-	-	-	-	-
Follow-up Hdwy	3.57	3.37	-	-	2.24	-
Pot Cap-1 Maneuver	249	811	-	-	1172	-
Stage 1	668	-	-	-	-	-
Stage 2	498	-	-	-	-	-
Platoon blocked, %			-	-		-
Mov Cap-1 Maneuver	194	811	-	-	1172	-
Mov Cap-2 Maneuver	303	-	-	-	-	-
Stage 1	668	-	-	-	-	-
Stage 2	388	-	-	-	-	-

Approach	WB	NB	SB
HCM Control Delay, s	13.2		
HCM LOS	B		

Minor Lane/Major Mvmt	NBT	NBR	WBLn1	SBL	SBT
Capacity (veh/h)	-	-	811	1172	-
HCM Lane V/C Ratio	-	-	0.462	0.22	-
HCM Control Delay (s)	-	-	13.2	8.9	-
HCM Lane LOS	-	-	B	A	-
HCM 95th %tile Q(veh)	-	-	2	1	-

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	4	150	8	46	25	38	12	160	16	153	279	12
Number	3	8	18	7	4	14	1	6	16	5	2	12
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1900	1863	1900	1900	1863	1863	1776	1776	1776	1759	1759	1900
Adj Flow Rate, veh/h	4	167	9	51	28	42	13	178	18	170	310	13
Adj No. of Lanes	0	1	0	0	1	1	1	1	1	1	1	0
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Percent Heavy Veh, %	2	2	2	2	2	2	7	7	7	8	8	8
Cap, veh/h	88	622	33	443	216	566	390	652	554	496	616	26
Arrive On Green	0.36	0.36	0.36	0.36	0.36	0.36	0.37	0.37	0.37	0.37	0.37	0.37
Sat Flow, veh/h	10	1740	92	860	603	1583	1003	1776	1509	1116	1677	70
Grp Volume(v), veh/h	180	0	0	79	0	42	13	178	18	170	0	323
Grp Sat Flow(s),veh/h/ln	1842	0	0	1463	0	1583	1003	1776	1509	1116	0	1747
Q Serve(g_s), s	0.0	0.0	0.0	0.0	0.0	0.8	0.4	3.1	0.3	5.5	0.0	6.3
Cycle Q Clear(g_c), s	3.0	0.0	0.0	1.2	0.0	0.8	6.7	3.1	0.3	8.6	0.0	6.3
Prop In Lane	0.02		0.05	0.65		1.00	1.00		1.00	1.00		0.04
Lane Grp Cap(c), veh/h	743	0	0	659	0	566	390	652	554	496	0	641
V/C Ratio(X)	0.24	0.00	0.00	0.12	0.00	0.07	0.03	0.27	0.03	0.34	0.00	0.50
Avail Cap(c_a), veh/h	929	0	0	799	0	727	666	1141	970	804	0	1122
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	0.00	0.00	1.00	0.00	1.00	1.00	1.00	1.00	1.00	0.00	1.00
Uniform Delay (d), s/veh	10.0	0.0	0.0	9.4	0.0	9.2	13.3	9.7	8.8	12.7	0.0	10.7
Incr Delay (d2), s/veh	0.2	0.0	0.0	0.1	0.0	0.1	0.0	0.2	0.0	0.4	0.0	0.6
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	1.5	0.0	0.0	0.7	0.0	0.3	0.1	1.5	0.1	1.8	0.0	3.1
LnGrp Delay(d),s/veh	10.1	0.0	0.0	9.5	0.0	9.3	13.3	9.9	8.9	13.1	0.0	11.3
LnGrp LOS	B			A		A	B	A	A	B		B
Approach Vol, veh/h		180			121			209			493	
Approach Delay, s/veh		10.1			9.4			10.0			11.9	
Approach LOS		B			A			B			B	

Timer	1	2	3	4	5	6	7	8
Assigned Phs		2		4		6		8
Phs Duration (G+Y+Rc), s		22.0		21.6		22.0		21.6
Change Period (Y+Rc), s		6.0		6.0		6.0		6.0
Max Green Setting (Gmax), s		28.0		20.0		28.0		20.0
Max Q Clear Time (g_c+I1), s		10.6		3.2		8.7		5.0
Green Ext Time (p_c), s		3.5		1.5		3.6		1.5

Intersection Summary	
HCM 2010 Ctrl Delay	10.9
HCM 2010 LOS	B

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	5	30	10	24	106	107	5	249	31	47	231	4
Number	3	8	18	7	4	14	1	6	16	5	2	12
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1900	1863	1900	1900	1863	1863	1810	1810	1810	1776	1776	1900
Adj Flow Rate, veh/h	6	33	11	27	118	119	6	277	34	52	257	4
Adj No. of Lanes	0	1	0	0	1	1	1	1	1	1	1	0
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Percent Heavy Veh, %	2	2	2	2	2	2	5	5	5	7	7	7
Cap, veh/h	122	458	137	162	579	568	443	663	564	421	639	10
Arrive On Green	0.36	0.36	0.36	0.36	0.36	0.36	0.37	0.37	0.37	0.37	0.37	0.37
Sat Flow, veh/h	82	1278	383	179	1617	1583	1082	1810	1538	1014	1744	27
Grp Volume(v), veh/h	50	0	0	145	0	119	6	277	34	52	0	261
Grp Sat Flow(s),veh/h/ln	1743	0	0	1796	0	1583	1082	1810	1538	1014	0	1771
Q Serve(g_s), s	0.0	0.0	0.0	0.0	0.0	2.3	0.2	5.0	0.6	1.8	0.0	4.8
Cycle Q Clear(g_c), s	0.8	0.0	0.0	2.4	0.0	2.3	5.0	5.0	0.6	6.8	0.0	4.8
Prop In Lane	0.12		0.22	0.19		1.00	1.00		1.00	1.00		0.02
Lane Grp Cap(c), veh/h	717	0	0	742	0	568	443	663	564	421	0	649
V/C Ratio(X)	0.07	0.00	0.00	0.20	0.00	0.21	0.01	0.42	0.06	0.12	0.00	0.40
Avail Cap(c_a), veh/h	922	0	0	955	0	762	716	1119	952	676	0	1096
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	0.00	0.00	1.00	0.00	1.00	1.00	1.00	1.00	1.00	0.00	1.00
Uniform Delay (d), s/veh	9.2	0.0	0.0	9.7	0.0	9.7	12.1	10.3	9.0	12.9	0.0	10.3
Incr Delay (d2), s/veh	0.0	0.0	0.0	0.1	0.0	0.2	0.0	0.4	0.0	0.1	0.0	0.4
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	0.4	0.0	0.0	1.2	0.0	1.0	0.1	2.5	0.3	0.5	0.0	2.4
LnGrp Delay(d),s/veh	9.3	0.0	0.0	9.9	0.0	9.9	12.1	10.8	9.0	13.0	0.0	10.7
LnGrp LOS	A			A		A	B	B	A	B		B
Approach Vol, veh/h		50			264			317			313	
Approach Delay, s/veh		9.3			9.9			10.6			11.1	
Approach LOS		A			A			B			B	

Timer	1	2	3	4	5	6	7	8
Assigned Phs		2		4		6		8
Phs Duration (G+Y+Rc), s		22.0		21.6		22.0		21.6
Change Period (Y+Rc), s		6.0		6.0		6.0		6.0
Max Green Setting (Gmax), s		27.0		21.0		27.0		21.0
Max Q Clear Time (g_c+I1), s		8.8		4.4		7.0		2.8
Green Ext Time (p_c), s		3.3		1.4		3.4		1.4

Intersection Summary	
HCM 2010 Ctrl Delay	10.5
HCM 2010 LOS	B

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Volume (veh/h)	9	9	171	6	12	319
Number	3	18	2	12	1	6
Initial Q (Qb), veh	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00	1.00		1.00	1.00	
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1652	1652	1810	1900	1776	1776
Adj Flow Rate, veh/h	10	10	190	7	13	354
Adj No. of Lanes	2	1	2	0	1	2
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90
Percent Heavy Veh, %	15	15	5	5	7	7
Cap, veh/h	141	65	1844	68	828	1839
Arrive On Green	0.05	0.05	0.55	0.55	0.55	0.55
Sat Flow, veh/h	3053	1404	3473	124	1126	3463
Grp Volume(v), veh/h	10	10	96	101	13	354
Grp Sat Flow(s),veh/h/ln	1526	1404	1719	1788	1126	1687
Q Serve(g_s), s	0.1	0.2	0.8	0.8	0.2	1.6
Cycle Q Clear(g_c), s	0.1	0.2	0.8	0.8	1.0	1.6
Prop In Lane	1.00	1.00		0.07	1.00	
Lane Grp Cap(c), veh/h	141	65	937	974	828	1839
V/C Ratio(X)	0.07	0.15	0.10	0.10	0.02	0.19
Avail Cap(c_a), veh/h	1560	718	1933	2010	1480	3793
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	13.4	13.4	3.2	3.2	3.5	3.4
Incr Delay (d2), s/veh	0.2	1.1	0.0	0.0	0.0	0.1
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	0.0	0.1	0.4	0.4	0.1	0.7
LnGrp Delay(d),s/veh	13.6	14.5	3.3	3.3	3.5	3.4
LnGrp LOS	B	B	A	A	A	A
Approach Vol, veh/h	20		197			367
Approach Delay, s/veh	14.1		3.3			3.4
Approach LOS	B		A			A

Timer	1	2	3	4	5	6	7	8
Assigned Phs		2				6		8
Phs Duration (G+Y+Rc), s		22.0				22.0		7.4
Change Period (Y+Rc), s		6.0				6.0		6.0
Max Green Setting (Gmax), s		33.0				33.0		15.0
Max Q Clear Time (g_c+I1), s		2.8				3.6		2.2
Green Ext Time (p_c), s		3.6				3.6		0.0

Intersection Summary	
HCM 2010 Ctrl Delay	3.7
HCM 2010 LOS	A

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Volume (veh/h)	6	22	301	13	10	231
Number	3	18	2	12	1	6
Initial Q (Qb), veh	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00	1.00		1.00	1.00	
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1652	1652	1827	1900	1810	1810
Adj Flow Rate, veh/h	7	24	334	14	11	257
Adj No. of Lanes	2	1	2	0	1	2
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90
Percent Heavy Veh, %	15	15	4	4	5	5
Cap, veh/h	208	96	1808	76	720	1830
Arrive On Green	0.07	0.07	0.53	0.53	0.53	0.53
Sat Flow, veh/h	3053	1404	3487	142	999	3529
Grp Volume(v), veh/h	7	24	170	178	11	257
Grp Sat Flow(s),veh/h/ln	1526	1404	1736	1802	999	1719
Q Serve(g_s), s	0.1	0.5	1.5	1.5	0.2	1.1
Cycle Q Clear(g_c), s	0.1	0.5	1.5	1.5	1.7	1.1
Prop In Lane	1.00	1.00		0.08	1.00	
Lane Grp Cap(c), veh/h	208	96	924	959	720	1830
V/C Ratio(X)	0.03	0.25	0.18	0.19	0.02	0.14
Avail Cap(c_a), veh/h	1727	794	1790	1859	1219	3547
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	13.1	13.3	3.6	3.6	4.1	3.6
Incr Delay (d2), s/veh	0.1	1.3	0.1	0.1	0.0	0.0
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	0.0	0.2	0.7	0.8	0.0	0.5
LnGrp Delay(d),s/veh	13.1	14.6	3.7	3.7	4.1	3.6
LnGrp LOS	B	B	A	A	A	A
Approach Vol, veh/h	31		348			268
Approach Delay, s/veh	14.3		3.7			3.6
Approach LOS	B		A			A

Timer	1	2	3	4	5	6	7	8
Assigned Phs		2				6		8
Phs Duration (G+Y+Rc), s		22.0				22.0		8.1
Change Period (Y+Rc), s		6.0				6.0		6.0
Max Green Setting (Gmax), s		31.0				31.0		17.0
Max Q Clear Time (g_c+I1), s		3.5				3.7		2.5
Green Ext Time (p_c), s		3.9				3.9		0.0

Intersection Summary	
HCM 2010 Ctrl Delay	4.2
HCM 2010 LOS	A

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	4	173	74	20	96	7	33	55	48	12	111	11
Number	5	2	12	1	6	16	3	8	18	7	4	14
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1810	1810	1900	1776	1776	1900	1792	1792	1900	1863	1863	1900
Adj Flow Rate, veh/h	4	192	82	22	107	8	37	61	53	13	123	12
Adj No. of Lanes	1	1	0	1	1	0	1	1	0	1	1	0
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Percent Heavy Veh, %	5	5	5	7	7	7	6	6	6	2	2	2
Cap, veh/h	513	366	157	398	760	57	438	271	235	461	510	50
Arrive On Green	0.30	0.30	0.30	0.05	0.47	0.47	0.31	0.31	0.31	0.31	0.31	0.31
Sat Flow, veh/h	1236	1204	514	1691	1632	122	1202	886	770	1273	1671	163
Grp Volume(v), veh/h	4	0	274	22	0	115	37	0	114	13	0	135
Grp Sat Flow(s),veh/h/ln	1236	0	1719	1691	0	1754	1202	0	1657	1273	0	1834
Q Serve(g_s), s	0.1	0.0	6.9	0.4	0.0	2.0	1.2	0.0	2.7	0.4	0.0	2.9
Cycle Q Clear(g_c), s	0.1	0.0	6.9	0.4	0.0	2.0	4.1	0.0	2.7	3.1	0.0	2.9
Prop In Lane	1.00		0.30	1.00		0.07	1.00		0.46	1.00		0.09
Lane Grp Cap(c), veh/h	513	0	523	398	0	817	438	0	506	461	0	560
V/C Ratio(X)	0.01	0.00	0.52	0.06	0.00	0.14	0.08	0.00	0.23	0.03	0.00	0.24
Avail Cap(c_a), veh/h	1033	0	1246	673	0	1841	599	0	727	631	0	805
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00	1.00
Uniform Delay (d), s/veh	12.7	0.0	15.1	10.7	0.0	8.0	15.2	0.0	13.6	14.7	0.0	13.7
Incr Delay (d2), s/veh	0.0	0.0	0.8	0.1	0.0	0.1	0.1	0.0	0.2	0.0	0.0	0.2
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	0.0	0.0	3.4	0.2	0.0	0.9	0.4	0.0	1.3	0.1	0.0	1.5
LnGrp Delay(d),s/veh	12.7	0.0	15.9	10.7	0.0	8.1	15.3	0.0	13.8	14.8	0.0	13.9
LnGrp LOS	B		B	B		A	B		B	B		B
Approach Vol, veh/h		278			137			151			148	
Approach Delay, s/veh		15.9			8.5			14.2			14.0	
Approach LOS		B			A			B			B	

Timer	1	2	3	4	5	6	7	8
Assigned Phs	1	2		4		6		8
Phs Duration (G+Y+Rc), s	8.5	21.9		22.0		30.4		22.0
Change Period (Y+Rc), s	6.0	6.0		6.0		6.0		6.0
Max Green Setting (Gmax), s	11.0	38.0		23.0		55.0		23.0
Max Q Clear Time (g_c+I1), s	2.4	8.9		5.1		4.0		6.1
Green Ext Time (p_c), s	0.0	2.5		1.5		2.7		1.4

Intersection Summary	
HCM 2010 Ctrl Delay	13.7
HCM 2010 LOS	B

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	7	96	55	39	170	17	57	113	45	5	48	5
Number	5	2	12	1	6	16	3	8	18	7	4	14
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1827	1827	1900	1792	1792	1900	1810	1810	1900	1863	1863	1900
Adj Flow Rate, veh/h	8	107	61	43	189	19	63	126	50	6	53	6
Adj No. of Lanes	1	1	0	1	1	0	1	1	0	1	1	0
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Percent Heavy Veh, %	4	4	4	6	6	6	5	5	5	2	2	2
Cap, veh/h	470	322	183	522	775	78	486	364	144	391	485	55
Arrive On Green	0.29	0.29	0.29	0.08	0.48	0.48	0.29	0.29	0.29	0.29	0.29	0.29
Sat Flow, veh/h	1147	1094	623	1707	1603	161	1300	1234	490	1204	1644	186
Grp Volume(v), veh/h	8	0	168	43	0	208	63	0	176	6	0	59
Grp Sat Flow(s),veh/h/ln	1147	0	1717	1707	0	1764	1300	0	1723	1204	0	1830
Q Serve(g_s), s	0.3	0.0	4.2	0.8	0.0	3.7	2.0	0.0	4.4	0.2	0.0	1.3
Cycle Q Clear(g_c), s	0.3	0.0	4.2	0.8	0.0	3.7	3.3	0.0	4.4	4.6	0.0	1.3
Prop In Lane	1.00		0.36	1.00		0.09	1.00		0.28	1.00		0.10
Lane Grp Cap(c), veh/h	470	0	505	522	0	853	486	0	508	391	0	540
V/C Ratio(X)	0.02	0.00	0.33	0.08	0.00	0.24	0.13	0.00	0.35	0.02	0.00	0.11
Avail Cap(c_a), veh/h	788	0	981	796	0	1626	773	0	889	658	0	945
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00	1.00
Uniform Delay (d), s/veh	13.6	0.0	15.0	10.0	0.0	8.2	15.1	0.0	15.0	16.8	0.0	13.9
Incr Delay (d2), s/veh	0.0	0.0	0.4	0.1	0.0	0.1	0.1	0.0	0.4	0.0	0.0	0.1
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	0.1	0.0	2.0	0.4	0.0	1.8	0.7	0.0	2.1	0.1	0.0	0.7
LnGrp Delay(d),s/veh	13.6	0.0	15.4	10.1	0.0	8.3	15.2	0.0	15.4	16.8	0.0	14.0
LnGrp LOS	B		B	B		A	B		B	B		B
Approach Vol, veh/h		176			251			239			65	
Approach Delay, s/veh		15.3			8.6			15.4			14.3	
Approach LOS		B			A			B			B	

Timer	1	2	3	4	5	6	7	8
Assigned Phs	1	2		4		6		8
Phs Duration (G+Y+Rc), s	10.3	22.0		22.0		32.2		22.0
Change Period (Y+Rc), s	6.0	6.0		6.0		6.0		6.0
Max Green Setting (Gmax), s	13.0	31.0		28.0		50.0		28.0
Max Q Clear Time (g_c+I1), s	2.8	6.2		6.6		5.7		6.4
Green Ext Time (p_c), s	0.0	2.3		1.5		2.5		1.5

Intersection Summary	
HCM 2010 Ctrl Delay	12.9
HCM 2010 LOS	B

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	102	370	89	160	151	22	53	323	192	49	561	86
Number	3	8	18	7	4	14	1	6	16	5	2	12
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1827	1827	1900	1827	1827	1900	1845	1845	1900	1845	1845	1845
Adj Flow Rate, veh/h	113	411	99	178	168	24	59	359	213	54	623	96
Adj No. of Lanes	1	2	0	1	2	0	1	1	0	1	1	1
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Percent Heavy Veh, %	4	4	4	4	4	4	3	3	3	3	3	3
Cap, veh/h	478	956	228	322	1050	148	247	489	290	272	831	706
Arrive On Green	0.34	0.34	0.34	0.34	0.34	0.34	0.45	0.45	0.45	0.45	0.45	0.45
Sat Flow, veh/h	1163	2781	664	869	3057	430	723	1086	645	829	1845	1568
Grp Volume(v), veh/h	113	255	255	178	94	98	59	0	572	54	623	96
Grp Sat Flow(s),veh/h/ln	1163	1736	1710	869	1736	1751	723	0	1731	829	1845	1568
Q Serve(g_s), s	4.4	6.6	6.7	11.6	2.2	2.3	4.3	0.0	15.8	3.3	16.3	2.1
Cycle Q Clear(g_c), s	6.6	6.6	6.7	18.3	2.2	2.3	20.6	0.0	15.8	19.1	16.3	2.1
Prop In Lane	1.00		0.39	1.00		0.25	1.00		0.37	1.00		1.00
Lane Grp Cap(c), veh/h	478	596	587	322	596	602	247	0	779	272	831	706
V/C Ratio(X)	0.24	0.43	0.43	0.55	0.16	0.16	0.24	0.00	0.73	0.20	0.75	0.14
Avail Cap(c_a), veh/h	478	596	587	322	596	602	269	0	833	297	887	754
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.00	1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	15.6	14.7	14.7	21.8	13.3	13.3	21.8	0.0	13.1	21.0	13.3	9.4
Incr Delay (d2), s/veh	0.3	0.5	0.5	2.0	0.1	0.1	0.5	0.0	3.2	0.4	3.4	0.1
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	1.4	3.2	3.2	3.0	1.1	1.1	0.9	0.0	8.2	0.8	8.9	0.9
LnGrp Delay(d),s/veh	15.8	15.2	15.2	23.8	13.4	13.4	22.3	0.0	16.3	21.3	16.6	9.5
LnGrp LOS	B	B	B	C	B	B	C		B	C	B	A
Approach Vol, veh/h		623			370			631			773	
Approach Delay, s/veh		15.3			18.4			16.9			16.1	
Approach LOS		B			B			B			B	

Timer	1	2	3	4	5	6	7	8
Assigned Phs		2		4		6		8
Phs Duration (G+Y+Rc), s		32.2		26.0		32.2		26.0
Change Period (Y+Rc), s		6.0		6.0		6.0		6.0
Max Green Setting (Gmax), s		28.0		20.0		28.0		20.0
Max Q Clear Time (g_c+I1), s		21.1		20.3		22.6		8.7
Green Ext Time (p_c), s		4.4		0.0		3.6		4.5

Intersection Summary	
HCM 2010 Ctrl Delay	16.5
HCM 2010 LOS	B

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	74	164	64	160	351	85	126	525	153	16	326	93
Number	3	8	18	7	4	14	1	6	16	5	2	12
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1845	1845	1900	1845	1845	1900	1845	1845	1900	1845	1845	1845
Adj Flow Rate, veh/h	82	182	71	178	390	94	140	583	170	18	362	103
Adj No. of Lanes	1	2	0	1	2	0	1	1	0	1	1	1
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Percent Heavy Veh, %	3	3	3	3	3	3	3	3	3	3	3	3
Cap, veh/h	274	702	264	374	791	189	481	697	203	227	936	795
Arrive On Green	0.28	0.28	0.28	0.28	0.28	0.28	0.51	0.51	0.51	0.51	0.51	0.51
Sat Flow, veh/h	899	2493	939	1111	2809	670	915	1373	401	700	1845	1568
Grp Volume(v), veh/h	82	126	127	178	242	242	140	0	753	18	362	103
Grp Sat Flow(s),veh/h/ln	899	1752	1679	1111	1752	1726	915	0	1774	700	1845	1568
Q Serve(g_s), s	4.8	3.2	3.3	8.4	6.5	6.7	6.3	0.0	20.7	1.3	6.8	2.0
Cycle Q Clear(g_c), s	11.4	3.2	3.3	11.8	6.5	6.7	13.1	0.0	20.7	21.9	6.8	2.0
Prop In Lane	1.00		0.56	1.00		0.39	1.00		0.23	1.00		1.00
Lane Grp Cap(c), veh/h	274	493	473	374	493	486	481	0	900	227	936	795
V/C Ratio(X)	0.30	0.26	0.27	0.48	0.49	0.50	0.29	0.00	0.84	0.08	0.39	0.13
Avail Cap(c_a), veh/h	274	493	473	374	493	486	532	0	999	267	1039	883
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.00	1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	21.8	15.8	15.9	20.4	17.0	17.1	12.6	0.0	12.0	21.4	8.6	7.4
Incr Delay (d2), s/veh	0.6	0.3	0.3	0.9	0.8	0.8	0.3	0.0	5.8	0.1	0.3	0.1
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	1.2	1.5	1.6	2.7	3.3	3.3	1.6	0.0	11.3	0.3	3.5	0.8
LnGrp Delay(d),s/veh	22.4	16.1	16.2	21.4	17.8	17.8	12.9	0.0	17.8	21.5	8.8	7.5
LnGrp LOS	C	B	B	C	B	B	B		B	C	A	A
Approach Vol, veh/h		335			662			893			483	
Approach Delay, s/veh		17.7			18.8			17.1			9.0	
Approach LOS		B			B			B			A	

Timer	1	2	3	4	5	6	7	8
Assigned Phs		2		4		6		8
Phs Duration (G+Y+Rc), s		34.8		22.0		34.8		22.0
Change Period (Y+Rc), s		6.0		6.0		6.0		6.0
Max Green Setting (Gmax), s		32.0		16.0		32.0		16.0
Max Q Clear Time (g_c+I1), s		23.9		13.8		22.7		13.4
Green Ext Time (p_c), s		4.9		1.3		5.5		1.4

Intersection Summary	
HCM 2010 Ctrl Delay	16.0
HCM 2010 LOS	B

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	345	159	115	4	51	4	50	193	4	4	419	267
Number	3	8	18	7	4	14	1	6	16	5	2	12
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1827	1827	1900	1845	1845	1900	1810	1810	1900	1845	1845	1845
Adj Flow Rate, veh/h	383	177	128	4	57	4	56	214	4	4	466	297
Adj No. of Lanes	1	2	0	1	2	0	1	1	0	1	1	1
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Percent Heavy Veh, %	4	4	4	3	3	3	5	5	5	3	3	3
Cap, veh/h	615	727	497	467	1225	85	269	685	13	494	714	607
Arrive On Green	0.37	0.37	0.37	0.37	0.37	0.37	0.39	0.39	0.39	0.39	0.39	0.39
Sat Flow, veh/h	1310	1974	1350	1060	3325	231	681	1771	33	1147	1845	1568
Grp Volume(v), veh/h	383	154	151	4	30	31	56	0	218	4	466	297
Grp Sat Flow(s),veh/h/ln	1310	1736	1589	1060	1752	1804	681	0	1804	1147	1845	1568
Q Serve(g_s), s	13.0	3.0	3.2	0.1	0.5	0.5	3.6	0.0	4.1	0.1	10.2	7.0
Cycle Q Clear(g_c), s	13.6	3.0	3.2	3.4	0.5	0.5	13.8	0.0	4.1	4.3	10.2	7.0
Prop In Lane	1.00		0.85	1.00		0.13	1.00		0.02	1.00		1.00
Lane Grp Cap(c), veh/h	615	639	585	467	645	664	269	0	698	494	714	607
V/C Ratio(X)	0.62	0.24	0.26	0.01	0.05	0.05	0.21	0.00	0.31	0.01	0.65	0.49
Avail Cap(c_a), veh/h	800	885	810	617	894	920	325	0	846	588	865	736
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.00	1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	14.3	10.7	10.8	12.0	10.0	10.0	18.0	0.0	10.5	12.0	12.3	11.4
Incr Delay (d2), s/veh	1.0	0.2	0.2	0.0	0.0	0.0	0.4	0.0	0.3	0.0	1.3	0.6
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	4.9	1.4	1.5	0.0	0.3	0.3	0.7	0.0	2.1	0.0	5.3	3.1
LnGrp Delay(d),s/veh	15.4	10.9	11.0	12.0	10.0	10.0	18.4	0.0	10.7	12.0	13.6	12.0
LnGrp LOS	B	B	B	B	A	A	B		B	B	B	B
Approach Vol, veh/h		688			65			274			767	
Approach Delay, s/veh		13.4			10.1			12.3			13.0	
Approach LOS		B			B			B			B	

Timer	1	2	3	4	5	6	7	8
Assigned Phs		2		4		6		8
Phs Duration (G+Y+Rc), s		25.0		24.1		25.0		24.1
Change Period (Y+Rc), s		6.0		6.0		6.0		6.0
Max Green Setting (Gmax), s		23.0		25.0		23.0		25.0
Max Q Clear Time (g_c+I1), s		12.2		5.4		15.8		15.6
Green Ext Time (p_c), s		4.2		3.4		3.2		2.5

Intersection Summary	
HCM 2010 Ctrl Delay	12.9
HCM 2010 LOS	B

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	357	62	53	13	111	4	147	449	7	7	224	374
Number	3	8	18	7	4	14	1	6	16	5	2	12
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1845	1845	1900	1863	1863	1900	1827	1827	1900	1845	1845	1845
Adj Flow Rate, veh/h	397	69	59	14	123	4	163	499	8	8	249	416
Adj No. of Lanes	1	2	0	1	2	0	1	1	0	1	1	1
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Percent Heavy Veh, %	3	3	3	2	2	2	4	4	4	3	3	3
Cap, veh/h	594	735	567	594	1365	44	352	687	11	264	707	601
Arrive On Green	0.39	0.39	0.39	0.39	0.39	0.39	0.38	0.38	0.38	0.38	0.38	0.38
Sat Flow, veh/h	1246	1885	1455	1257	3499	113	753	1793	29	880	1845	1568
Grp Volume(v), veh/h	397	64	64	14	62	65	163	0	507	8	249	416
Grp Sat Flow(s),veh/h/ln	1246	1752	1588	1257	1770	1843	753	0	1822	880	1845	1568
Q Serve(g_s), s	15.6	1.2	1.4	0.4	1.2	1.2	10.4	0.0	12.6	0.4	5.1	11.8
Cycle Q Clear(g_c), s	16.8	1.2	1.4	1.7	1.2	1.2	15.5	0.0	12.6	13.0	5.1	11.8
Prop In Lane	1.00		0.92	1.00		0.06	1.00		0.02	1.00		1.00
Lane Grp Cap(c), veh/h	594	683	619	594	690	719	352	0	698	264	707	601
V/C Ratio(X)	0.67	0.09	0.10	0.02	0.09	0.09	0.46	0.00	0.73	0.03	0.35	0.69
Avail Cap(c_a), veh/h	721	861	780	721	869	905	377	0	757	293	767	652
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.00	1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	15.5	10.2	10.3	10.8	10.2	10.2	17.2	0.0	13.9	19.5	11.6	13.7
Incr Delay (d2), s/veh	1.8	0.1	0.1	0.0	0.1	0.1	0.9	0.0	3.2	0.0	0.3	2.9
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	5.6	0.6	0.6	0.1	0.6	0.6	2.2	0.0	6.8	0.1	2.6	5.6
LnGrp Delay(d),s/veh	17.3	10.3	10.3	10.8	10.3	10.3	18.1	0.0	17.2	19.5	11.9	16.6
LnGrp LOS	B	B	B	B	B	B	B		B	B	B	B
Approach Vol, veh/h		525			141			670			673	
Approach Delay, s/veh		15.6			10.3			17.4			14.9	
Approach LOS		B			B			B			B	

Timer	1	2	3	4	5	6	7	8
Assigned Phs		2		4		6		8
Phs Duration (G+Y+Rc), s		26.3		26.6		26.3		26.6
Change Period (Y+Rc), s		6.0		6.0		6.0		6.0
Max Green Setting (Gmax), s		22.0		26.0		22.0		26.0
Max Q Clear Time (g_c+I1), s		15.0		3.7		17.5		18.8
Green Ext Time (p_c), s		3.9		2.9		2.8		1.8

Intersection Summary	
HCM 2010 Ctrl Delay	15.6
HCM 2010 LOS	B

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	35	36	101	4	26	5	83	249	6	6	479	89
Number	3	8	18	7	4	14	1	6	16	5	2	12
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1900	1776	1900	1792	1792	1900	1827	1827	1900	1810	1810	1900
Adj Flow Rate, veh/h	39	40	112	4	29	6	92	277	7	7	532	99
Adj No. of Lanes	0	1	0	1	1	0	1	1	0	1	1	0
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Percent Heavy Veh, %	7	7	7	6	6	6	4	4	4	5	5	5
Cap, veh/h	124	122	243	441	386	80	327	935	24	589	782	146
Arrive On Green	0.27	0.27	0.27	0.27	0.27	0.27	0.53	0.53	0.53	0.53	0.53	0.53
Sat Flow, veh/h	186	455	908	1184	1442	298	777	1774	45	1060	1485	276
Grp Volume(v), veh/h	191	0	0	4	0	35	92	0	284	7	0	631
Grp Sat Flow(s),veh/h/ln	1548	0	0	1184	0	1740	777	0	1819	1060	0	1761
Q Serve(g_s), s	0.0	0.0	0.0	0.0	0.0	0.9	5.8	0.0	5.1	0.2	0.0	15.4
Cycle Q Clear(g_c), s	5.8	0.0	0.0	0.1	0.0	0.9	21.2	0.0	5.1	5.3	0.0	15.4
Prop In Lane	0.20		0.59	1.00		0.17	1.00		0.02	1.00		0.16
Lane Grp Cap(c), veh/h	488	0	0	441	0	465	327	0	958	589	0	928
V/C Ratio(X)	0.39	0.00	0.00	0.01	0.00	0.08	0.28	0.00	0.30	0.01	0.00	0.68
Avail Cap(c_a), veh/h	653	0	0	571	0	656	663	0	1745	1047	0	1689
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	0.00	0.00	1.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00	1.00
Uniform Delay (d), s/veh	17.8	0.0	0.0	15.7	0.0	16.0	18.0	0.0	7.7	9.2	0.0	10.2
Incr Delay (d2), s/veh	0.5	0.0	0.0	0.0	0.0	0.1	0.5	0.0	0.2	0.0	0.0	0.9
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	2.6	0.0	0.0	0.0	0.0	0.4	1.3	0.0	2.6	0.1	0.0	7.6
LnGrp Delay(d),s/veh	18.3	0.0	0.0	15.7	0.0	16.1	18.5	0.0	7.9	9.2	0.0	11.1
LnGrp LOS	B			B		B	B		A	A		B
Approach Vol, veh/h		191			39			376			638	
Approach Delay, s/veh		18.3			16.0			10.5			11.0	
Approach LOS		B			B			B			B	

Timer	1	2	3	4	5	6	7	8
Assigned Phs		2		4		6		8
Phs Duration (G+Y+Rc), s		36.8		21.6		36.8		21.6
Change Period (Y+Rc), s		6.0		6.0		6.0		6.0
Max Green Setting (Gmax), s		56.0		22.0		56.0		22.0
Max Q Clear Time (g_c+I1), s		17.4		2.9		23.2		7.8
Green Ext Time (p_c), s		7.8		1.3		7.6		1.1

Intersection Summary	
HCM 2010 Ctrl Delay	12.1
HCM 2010 LOS	B

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	47	26	89	4	36	15	117	531	4	13	247	60
Number	3	8	18	7	4	14	1	6	16	5	2	12
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1900	1810	1900	1810	1810	1900	1845	1845	1900	1827	1827	1900
Adj Flow Rate, veh/h	52	29	99	4	40	17	130	590	4	14	274	67
Adj No. of Lanes	0	1	0	1	1	0	1	1	0	1	1	0
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Percent Heavy Veh, %	5	5	5	5	5	5	3	3	3	4	4	4
Cap, veh/h	183	118	256	537	364	155	484	849	6	308	658	161
Arrive On Green	0.30	0.30	0.30	0.30	0.30	0.30	0.46	0.46	0.46	0.46	0.46	0.46
Sat Flow, veh/h	305	389	848	1221	1206	513	1025	1830	12	804	1419	347
Grp Volume(v), veh/h	180	0	0	4	0	57	130	0	594	14	0	341
Grp Sat Flow(s),veh/h/ln	1541	0	0	1221	0	1719	1025	0	1842	804	0	1766
Q Serve(g_s), s	0.0	0.0	0.0	0.0	0.0	1.2	4.9	0.0	13.1	0.7	0.0	6.6
Cycle Q Clear(g_c), s	4.4	0.0	0.0	0.1	0.0	1.2	11.5	0.0	13.1	13.8	0.0	6.6
Prop In Lane	0.29		0.55	1.00		0.30	1.00		0.01	1.00		0.20
Lane Grp Cap(c), veh/h	556	0	0	537	0	519	484	0	855	308	0	819
V/C Ratio(X)	0.32	0.00	0.00	0.01	0.00	0.11	0.27	0.00	0.70	0.05	0.00	0.42
Avail Cap(c_a), veh/h	776	0	0	716	0	771	1109	0	1977	798	0	1895
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	0.00	0.00	1.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00	1.00
Uniform Delay (d), s/veh	14.0	0.0	0.0	12.5	0.0	12.9	13.0	0.0	10.9	16.3	0.0	9.1
Incr Delay (d2), s/veh	0.3	0.0	0.0	0.0	0.0	0.1	0.3	0.0	1.0	0.1	0.0	0.3
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	2.1	0.0	0.0	0.0	0.0	0.6	1.4	0.0	6.8	0.2	0.0	3.2
LnGrp Delay(d),s/veh	14.3	0.0	0.0	12.5	0.0	13.0	13.3	0.0	11.9	16.4	0.0	9.5
LnGrp LOS	B			B		B	B		B	B		A
Approach Vol, veh/h		180			61			724			355	
Approach Delay, s/veh		14.3			13.0			12.1			9.7	
Approach LOS		B			B			B			A	

Timer	1	2	3	4	5	6	7	8
Assigned Phs		2		4		6		8
Phs Duration (G+Y+Rc), s		29.8		21.5		29.8		21.5
Change Period (Y+Rc), s		6.0		6.0		6.0		6.0
Max Green Setting (Gmax), s		55.0		23.0		55.0		23.0
Max Q Clear Time (g_c+I1), s		15.8		3.2		15.1		6.4
Green Ext Time (p_c), s		8.0		1.3		8.0		1.2

Intersection Summary	
HCM 2010 Ctrl Delay	11.8
HCM 2010 LOS	B

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Volume (veh/h)	39	0	315	59	0	564
Number	7	14	6	16	5	2
Initial Q (Qb), veh	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00	1.00		1.00	1.00	
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1743	1743	1792	1792	0	1827
Adj Flow Rate, veh/h	43	0	350	0	0	627
Adj No. of Lanes	1	1	1	1	0	1
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90
Percent Heavy Veh, %	9	9	6	6	0	4
Cap, veh/h	148	132	962	818	0	981
Arrive On Green	0.09	0.00	0.54	0.00	0.00	0.54
Sat Flow, veh/h	1660	1482	1792	1524	0	1827
Grp Volume(v), veh/h	43	0	350	0	0	627
Grp Sat Flow(s),veh/h/ln	1660	1482	1792	1524	0	1827
Q Serve(g_s), s	0.8	0.0	3.6	0.0	0.0	7.8
Cycle Q Clear(g_c), s	0.8	0.0	3.6	0.0	0.0	7.8
Prop In Lane	1.00	1.00		1.00	0.00	
Lane Grp Cap(c), veh/h	148	132	962	818	0	981
V/C Ratio(X)	0.29	0.00	0.36	0.00	0.00	0.64
Avail Cap(c_a), veh/h	569	508	2625	2232	0	2676
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	0.00	1.00	0.00	0.00	1.00
Uniform Delay (d), s/veh	13.7	0.0	4.3	0.0	0.0	5.2
Incr Delay (d2), s/veh	1.1	0.0	0.2	0.0	0.0	0.7
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	0.4	0.0	1.8	0.0	0.0	4.0
LnGrp Delay(d),s/veh	14.7	0.0	4.5	0.0	0.0	5.9
LnGrp LOS	B		A			A
Approach Vol, veh/h	43		350			627
Approach Delay, s/veh	14.7		4.5			5.9
Approach LOS	B		A			A

Timer	1	2	3	4	5	6	7	8
Assigned Phs		2		4		6		
Phs Duration (G+Y+Rc), s		23.2		8.9		23.2		
Change Period (Y+Rc), s		6.0		6.0		6.0		
Max Green Setting (Gmax), s		47.0		11.0		47.0		
Max Q Clear Time (g_c+I1), s		9.8		2.8		5.6		
Green Ext Time (p_c), s		7.5		0.0		7.6		

Intersection Summary	
HCM 2010 Ctrl Delay	5.8
HCM 2010 LOS	A

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Volume (veh/h)	41	0	590	54	0	334
Number	7	14	6	16	5	2
Initial Q (Qb), veh	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00	1.00		1.00	1.00	
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1759	1759	1827	1827	0	1845
Adj Flow Rate, veh/h	46	0	656	0	0	371
Adj No. of Lanes	1	1	1	1	0	1
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90
Percent Heavy Veh, %	8	8	4	4	0	3
Cap, veh/h	157	140	1004	853	0	1014
Arrive On Green	0.09	0.00	0.55	0.00	0.00	0.55
Sat Flow, veh/h	1675	1495	1827	1553	0	1845
Grp Volume(v), veh/h	46	0	656	0	0	371
Grp Sat Flow(s),veh/h/ln	1675	1495	1827	1553	0	1845
Q Serve(g_s), s	0.9	0.0	8.5	0.0	0.0	3.8
Cycle Q Clear(g_c), s	0.9	0.0	8.5	0.0	0.0	3.8
Prop In Lane	1.00	1.00		1.00	0.00	
Lane Grp Cap(c), veh/h	157	140	1004	853	0	1014
V/C Ratio(X)	0.29	0.00	0.65	0.00	0.00	0.37
Avail Cap(c_a), veh/h	548	489	2555	2172	0	2580
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	0.00	1.00	0.00	0.00	1.00
Uniform Delay (d), s/veh	14.2	0.0	5.3	0.0	0.0	4.3
Incr Delay (d2), s/veh	1.0	0.0	0.7	0.0	0.0	0.2
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	0.4	0.0	4.4	0.0	0.0	1.9
LnGrp Delay(d),s/veh	15.2	0.0	6.0	0.0	0.0	4.5
LnGrp LOS	B		A			A
Approach Vol, veh/h	46		656			371
Approach Delay, s/veh	15.2		6.0			4.5
Approach LOS	B		A			A

Timer	1	2	3	4	5	6	7	8
Assigned Phs		2		4		6		
Phs Duration (G+Y+Rc), s		24.5		9.1		24.5		
Change Period (Y+Rc), s		6.0		6.0		6.0		
Max Green Setting (Gmax), s		47.0		11.0		47.0		
Max Q Clear Time (g_c+I1), s		5.8		2.9		10.5		
Green Ext Time (p_c), s		8.1		0.0		8.0		

Intersection Summary	
HCM 2010 Ctrl Delay	5.9
HCM 2010 LOS	A

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	5	285	11	63	68	81	17	238	218	157	356	18
Number	3	8	18	7	4	14	1	6	16	5	2	12
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1900	1863	1900	1827	1827	1827	1810	1810	1900	1792	1792	1900
Adj Flow Rate, veh/h	6	317	12	70	76	90	19	264	242	174	396	20
Adj No. of Lanes	0	2	0	1	1	1	1	1	0	1	1	0
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Percent Heavy Veh, %	2	2	2	4	4	4	5	5	5	6	6	6
Cap, veh/h	71	960	36	342	519	441	458	438	402	373	852	43
Arrive On Green	0.28	0.28	0.28	0.28	0.28	0.28	0.50	0.50	0.50	0.50	0.50	0.50
Sat Flow, veh/h	17	3383	126	1027	1827	1553	939	871	798	856	1692	85
Grp Volume(v), veh/h	176	0	159	70	76	90	19	0	506	174	0	416
Grp Sat Flow(s),veh/h/ln	1854	0	1673	1027	1827	1553	939	0	1669	856	0	1777
Q Serve(g_s), s	0.0	0.0	4.2	3.3	1.8	2.5	0.8	0.0	12.2	10.3	0.0	8.6
Cycle Q Clear(g_c), s	4.2	0.0	4.2	7.5	1.8	2.5	9.3	0.0	12.2	22.4	0.0	8.6
Prop In Lane	0.03		0.08	1.00		1.00	1.00		0.48	1.00		0.05
Lane Grp Cap(c), veh/h	592	0	475	342	519	441	458	0	840	373	0	895
V/C Ratio(X)	0.30	0.00	0.33	0.20	0.15	0.20	0.04	0.00	0.60	0.47	0.00	0.47
Avail Cap(c_a), veh/h	592	0	475	342	519	441	518	0	947	429	0	1009
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	0.00	1.00	1.00	1.00	1.00	1.00	0.00	1.00	1.00	0.00	1.00
Uniform Delay (d), s/veh	16.0	0.0	16.0	18.9	15.1	15.3	12.1	0.0	10.0	18.0	0.0	9.1
Incr Delay (d2), s/veh	0.3	0.0	0.4	0.3	0.1	0.2	0.0	0.0	0.9	0.9	0.0	0.4
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	2.2	0.0	2.0	0.9	0.9	1.1	0.2	0.0	5.7	2.5	0.0	4.3
LnGrp Delay(d),s/veh	16.2	0.0	16.4	19.2	15.2	15.6	12.1	0.0	10.9	18.9	0.0	9.5
LnGrp LOS	B		B	B	B	B	B		B	B		A
Approach Vol, veh/h		335			236			525			590	
Approach Delay, s/veh		16.3			16.5			10.9			12.2	
Approach LOS		B			B			B			B	

Timer	1	2	3	4	5	6	7	8
Assigned Phs		2		4		6		8
Phs Duration (G+Y+Rc), s		34.4		22.0		34.4		22.0
Change Period (Y+Rc), s		6.0		6.0		6.0		6.0
Max Green Setting (Gmax), s		32.0		16.0		32.0		16.0
Max Q Clear Time (g_c+I1), s		24.4		9.5		14.2		6.2
Green Ext Time (p_c), s		3.9		1.7		6.6		2.2

Intersection Summary	
HCM 2010 Ctrl Delay	13.2
HCM 2010 LOS	B

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	24	68	25	216	211	208	16	370	100	73	283	12
Number	3	8	18	7	4	14	1	6	16	5	2	12
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1900	1863	1900	1845	1845	1845	1827	1827	1900	1827	1827	1900
Adj Flow Rate, veh/h	27	76	28	240	234	231	18	411	111	81	314	13
Adj No. of Lanes	0	2	0	1	1	1	1	1	0	1	1	0
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Percent Heavy Veh, %	2	2	2	3	3	3	4	4	4	4	4	4
Cap, veh/h	222	569	218	517	594	505	467	606	164	316	761	32
Arrive On Green	0.32	0.32	0.32	0.32	0.32	0.32	0.44	0.44	0.44	0.44	0.44	0.44
Sat Flow, veh/h	374	1767	678	1272	1845	1568	1028	1386	374	860	1742	72
Grp Volume(v), veh/h	66	0	65	240	234	231	18	0	522	81	0	327
Grp Sat Flow(s),veh/h/ln	1243	0	1575	1272	1845	1568	1028	0	1761	860	0	1814
Q Serve(g_s), s	0.1	0.0	1.5	8.2	4.9	5.8	0.6	0.0	11.8	4.1	0.0	6.2
Cycle Q Clear(g_c), s	5.0	0.0	1.5	9.6	4.9	5.8	6.8	0.0	11.8	15.9	0.0	6.2
Prop In Lane	0.41		0.43	1.00		1.00	1.00		0.21	1.00		0.04
Lane Grp Cap(c), veh/h	502	0	507	517	594	505	467	0	769	316	0	793
V/C Ratio(X)	0.13	0.00	0.13	0.46	0.39	0.46	0.04	0.00	0.68	0.26	0.00	0.41
Avail Cap(c_a), veh/h	634	0	665	645	779	662	576	0	956	408	0	985
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	0.00	1.00	1.00	1.00	1.00	1.00	0.00	1.00	1.00	0.00	1.00
Uniform Delay (d), s/veh	11.9	0.0	11.9	15.3	13.1	13.4	11.9	0.0	11.2	17.6	0.0	9.6
Incr Delay (d2), s/veh	0.1	0.0	0.1	0.6	0.4	0.6	0.0	0.0	1.4	0.4	0.0	0.3
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	0.7	0.0	0.6	3.0	2.5	2.6	0.2	0.0	6.0	1.0	0.0	3.1
LnGrp Delay(d),s/veh	12.0	0.0	12.0	16.0	13.5	14.1	12.0	0.0	12.6	18.0	0.0	10.0
LnGrp LOS	B		B	B	B	B	B		B	B		A
Approach Vol, veh/h		131			705			540			408	
Approach Delay, s/veh		12.0			14.5			12.6			11.6	
Approach LOS		B			B			B			B	

Timer	1	2	3	4	5	6	7	8
Assigned Phs		2		4		6		8
Phs Duration (G+Y+Rc), s		27.7		22.0		27.7		22.0
Change Period (Y+Rc), s		6.0		6.0		6.0		6.0
Max Green Setting (Gmax), s		27.0		21.0		27.0		21.0
Max Q Clear Time (g_c+I1), s		17.9		11.6		13.8		7.0
Green Ext Time (p_c), s		3.8		2.8		4.7		3.4

Intersection Summary	
HCM 2010 Ctrl Delay	13.1
HCM 2010 LOS	B

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	12	4	8	16	4	29	8	484	25	43	422	10
Number	7	4	14	3	8	18	5	2	12	1	6	16
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1652	1652	1900	1863	1863	1900	1810	1810	1900	1810	1810	1900
Adj Flow Rate, veh/h	13	4	9	18	4	32	9	538	28	48	469	11
Adj No. of Lanes	1	2	0	1	2	0	1	1	0	1	1	0
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Percent Heavy Veh, %	15	15	15	2	2	2	5	5	5	5	5	5
Cap, veh/h	415	354	316	468	399	357	451	863	45	389	892	21
Arrive On Green	0.23	0.23	0.23	0.23	0.23	0.23	0.51	0.51	0.51	0.51	0.51	0.51
Sat Flow, veh/h	1212	1570	1404	1395	1770	1583	885	1705	89	817	1761	41
Grp Volume(v), veh/h	13	4	9	18	4	32	9	0	566	48	0	480
Grp Sat Flow(s),veh/h/ln	1212	1570	1404	1395	1770	1583	885	0	1794	817	0	1802
Q Serve(g_s), s	0.4	0.1	0.2	0.5	0.1	0.7	0.3	0.0	10.2	2.0	0.0	8.0
Cycle Q Clear(g_c), s	1.1	0.1	0.2	0.7	0.1	0.7	8.3	0.0	10.2	12.2	0.0	8.0
Prop In Lane	1.00		1.00	1.00		1.00	1.00		0.05	1.00		0.02
Lane Grp Cap(c), veh/h	415	354	316	468	399	357	451	0	908	389	0	913
V/C Ratio(X)	0.03	0.01	0.03	0.04	0.01	0.09	0.02	0.00	0.62	0.12	0.00	0.53
Avail Cap(c_a), veh/h	630	632	565	716	712	637	1190	0	2407	1072	0	2418
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.00	1.00	1.00	0.00	1.00
Uniform Delay (d), s/veh	14.1	13.5	13.5	13.8	13.4	13.7	10.2	0.0	8.0	12.4	0.0	7.4
Incr Delay (d2), s/veh	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.7	0.1	0.0	0.5
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	0.1	0.0	0.1	0.2	0.0	0.3	0.1	0.0	5.1	0.5	0.0	4.0
LnGrp Delay(d),s/veh	14.2	13.5	13.5	13.8	13.5	13.8	10.2	0.0	8.7	12.5	0.0	7.9
LnGrp LOS	B	B	B	B	B	B	B		A	B		A
Approach Vol, veh/h		26			54			575			528	
Approach Delay, s/veh		13.8			13.8			8.7			8.3	
Approach LOS		B			B			A			A	

Timer	1	2	3	4	5	6	7	8
Assigned Phs		2		4		6		8
Phs Duration (G+Y+Rc), s		28.6		16.1		28.6		16.1
Change Period (Y+Rc), s		6.0		6.0		6.0		6.0
Max Green Setting (Gmax), s		60.0		18.0		60.0		18.0
Max Q Clear Time (g_c+I1), s		12.2		3.1		14.2		2.7
Green Ext Time (p_c), s		8.5		0.2		8.5		0.2

Intersection Summary	
HCM 2010 Ctrl Delay	8.9
HCM 2010 LOS	A

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	13	4	7	23	4	38	5	449	14	24	496	7
Number	7	4	14	3	8	18	5	2	12	1	6	16
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1652	1652	1900	1863	1863	1900	1827	1827	1900	1827	1827	1900
Adj Flow Rate, veh/h	14	4	8	26	4	42	6	499	16	27	551	8
Adj No. of Lanes	1	2	0	1	2	0	1	1	0	1	1	0
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Percent Heavy Veh, %	15	15	15	2	2	2	4	4	4	4	4	4
Cap, veh/h	443	398	356	511	448	401	365	836	27	394	853	12
Arrive On Green	0.25	0.25	0.25	0.25	0.25	0.25	0.48	0.48	0.48	0.48	0.48	0.48
Sat Flow, veh/h	1201	1570	1404	1397	1770	1583	831	1761	56	865	1796	26
Grp Volume(v), veh/h	14	4	8	26	4	42	6	0	515	27	0	559
Grp Sat Flow(s),veh/h/ln	1201	1570	1404	1397	1770	1583	831	0	1817	865	0	1822
Q Serve(g_s), s	0.4	0.1	0.2	0.6	0.1	0.9	0.2	0.0	9.2	1.0	0.0	10.3
Cycle Q Clear(g_c), s	1.3	0.1	0.2	0.8	0.1	0.9	10.5	0.0	9.2	10.2	0.0	10.3
Prop In Lane	1.00		1.00	1.00		1.00	1.00		0.03	1.00		0.01
Lane Grp Cap(c), veh/h	443	398	356	511	448	401	365	0	863	394	0	866
V/C Ratio(X)	0.03	0.01	0.02	0.05	0.01	0.10	0.02	0.00	0.60	0.07	0.00	0.65
Avail Cap(c_a), veh/h	655	675	604	757	761	681	1079	0	2426	1138	0	2433
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.00	1.00	1.00	0.00	1.00
Uniform Delay (d), s/veh	13.2	12.4	12.4	12.7	12.3	12.7	12.8	0.0	8.5	12.2	0.0	8.8
Incr Delay (d2), s/veh	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.7	0.1	0.0	0.8
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	0.1	0.0	0.1	0.2	0.0	0.4	0.1	0.0	4.6	0.3	0.0	5.3
LnGrp Delay(d),s/veh	13.2	12.4	12.4	12.7	12.4	12.8	12.8	0.0	9.2	12.3	0.0	9.6
LnGrp LOS	B	B	B	B	B	B	B		A	B		A
Approach Vol, veh/h		26			72			521			586	
Approach Delay, s/veh		12.8			12.7			9.2			9.7	
Approach LOS		B			B			A			A	

Timer	1	2	3	4	5	6	7	8
Assigned Phs		2		4		6		8
Phs Duration (G+Y+Rc), s		27.0		17.2		27.0		17.2
Change Period (Y+Rc), s		6.0		6.0		6.0		6.0
Max Green Setting (Gmax), s		59.0		19.0		59.0		19.0
Max Q Clear Time (g_c+I1), s		12.5		3.3		12.3		2.9
Green Ext Time (p_c), s		8.5		0.3		8.5		0.3

Intersection Summary	
HCM 2010 Ctrl Delay	9.7
HCM 2010 LOS	A

Intersection	
Int Delay, s/veh	2.6

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Vol, veh/h	105	506	259	33	34	74
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	-	-	-	-	0	-
Veh in Median Storage, #	-	0	0	-	0	-
Grade, %	-	0	0	-	0	-
Peak Hour Factor	90	90	90	90	90	90
Heavy Vehicles, %	4	4	5	5	2	2
Mvmt Flow	117	562	288	37	38	82

Major/Minor	Major1		Major2		Minor2	
Conflicting Flow All	324	0	-	0	820	162
Stage 1	-	-	-	-	306	-
Stage 2	-	-	-	-	514	-
Critical Hdwy	4.18	-	-	-	6.84	6.94
Critical Hdwy Stg 1	-	-	-	-	5.84	-
Critical Hdwy Stg 2	-	-	-	-	5.84	-
Follow-up Hdwy	2.24	-	-	-	3.52	3.32
Pot Cap-1 Maneuver	1218	-	-	-	313	854
Stage 1	-	-	-	-	720	-
Stage 2	-	-	-	-	565	-
Platoon blocked, %		-	-	-		
Mov Cap-1 Maneuver	1218	-	-	-	269	854
Mov Cap-2 Maneuver	-	-	-	-	269	-
Stage 1	-	-	-	-	720	-
Stage 2	-	-	-	-	486	-

Approach	EB	WB	SB
HCM Control Delay, s	1.8		14.3
HCM LOS			B

Minor Lane/Major Mvmt	EBL	EBT	WBT	WBR	SBLn1
Capacity (veh/h)	1218	-	-	-	507
HCM Lane V/C Ratio	0.096	-	-	-	0.237
HCM Control Delay (s)	8.3	0.4	-	-	14.3
HCM Lane LOS	A	A	-	-	B
HCM 95th %tile Q(veh)	0	-	-	-	1

Intersection	
Int Delay, s/veh	2.5

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Vol, veh/h	70	263	493	45	23	103
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	-	-	-	-	0	-
Veh in Median Storage, #	-	0	0	-	0	-
Grade, %	-	0	0	-	0	-
Peak Hour Factor	90	90	90	90	90	90
Heavy Vehicles, %	3	3	4	4	2	2
Mvmt Flow	78	292	548	50	26	114

Major/Minor	Major1		Major2		Minor2	
Conflicting Flow All	598	0	-	0	875	299
Stage 1	-	-	-	-	573	-
Stage 2	-	-	-	-	302	-
Critical Hdwy	4.16	-	-	-	6.84	6.94
Critical Hdwy Stg 1	-	-	-	-	5.84	-
Critical Hdwy Stg 2	-	-	-	-	5.84	-
Follow-up Hdwy	2.23	-	-	-	3.52	3.32
Pot Cap-1 Maneuver	968	-	-	-	289	697
Stage 1	-	-	-	-	527	-
Stage 2	-	-	-	-	724	-
Platoon blocked, %		-	-	-		
Mov Cap-1 Maneuver	968	-	-	-	261	697
Mov Cap-2 Maneuver	-	-	-	-	261	-
Stage 1	-	-	-	-	527	-
Stage 2	-	-	-	-	654	-

Approach	EB	WB	SB
HCM Control Delay, s	2.1		14.1
HCM LOS			B

Minor Lane/Major Mvmt	EBL	EBT	WBT	WBR	SBLn1
Capacity (veh/h)	968	-	-	-	534
HCM Lane V/C Ratio	0.08	-	-	-	0.262
HCM Control Delay (s)	9	0.3	-	-	14.1
HCM Lane LOS	A	A	-	-	B
HCM 95th %tile Q(veh)	0	-	-	-	1

Intersection	
Int Delay, s/veh	3.4

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR
Vol, veh/h	327	205	4	5	102	16	4	5	6
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Free	Free	Stop	Stop	Stop
RT Channelized	-	-	None	-	-	None	-	-	None
Storage Length	-	-	-	-	-	-	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-
Peak Hour Factor	90	90	90	90	90	90	90	90	90
Heavy Vehicles, %	5	5	5	5	5	5	2	2	2
Mvmt Flow	363	228	4	6	113	18	4	6	7

Major/Minor	Major1			Major2			Minor1		
Conflicting Flow All	131	0	0	232	0	0	1027	1099	116
Stage 1	-	-	-	-	-	-	957	957	-
Stage 2	-	-	-	-	-	-	70	142	-
Critical Hdwy	4.2	-	-	4.2	-	-	7.54	6.54	6.94
Critical Hdwy Stg 1	-	-	-	-	-	-	6.54	5.54	-
Critical Hdwy Stg 2	-	-	-	-	-	-	6.54	5.54	-
Follow-up Hdwy	2.25	-	-	2.25	-	-	3.52	4.02	3.32
Pot Cap-1 Maneuver	1430	-	-	1311	-	-	189	211	914
Stage 1	-	-	-	-	-	-	277	334	-
Stage 2	-	-	-	-	-	-	932	778	-
Platoon blocked, %		-	-		-	-			
Mov Cap-1 Maneuver	1430	-	-	1311	-	-	109	149	914
Mov Cap-2 Maneuver	-	-	-	-	-	-	109	149	-
Stage 1	-	-	-	-	-	-	196	236	-
Stage 2	-	-	-	-	-	-	706	774	-

Approach	EB	WB	NB
HCM Control Delay, s			25.2
HCM LOS			D

Minor Lane/Major Mvmt	NBLn1	EBL	EBT	EBR	WBL	WBT	WBR	SBLn1	SBLn2
Capacity (veh/h)	195	1430	-	-	1311	-	-	149	975
HCM Lane V/C Ratio	0.085	0.254	-	-	0.004	-	-	0.157	0.235
HCM Control Delay (s)	25.2	8.4	0.3	-	7.8	0	-	33.6	9.8
HCM Lane LOS	D	A	A	-	A	A	-	D	A
HCM 95th %tile Q(veh)	0	1	-	-	0	-	-	1	1

Intersection			
Int Delay, s/veh			

Movement	SBL	SBT	SBR
Vol, veh/h	17	4	206
Conflicting Peds, #/hr	0	0	0
Sign Control	Stop	Stop	Stop
RT Channelized	-	-	None
Storage Length	-	-	0
Veh in Median Storage, #	-	0	-
Grade, %	-	0	-
Peak Hour Factor	90	90	90
Heavy Vehicles, %	5	5	5
Mvmt Flow	19	4	229

Major/Minor	Minor2		
Conflicting Flow All	976	1092	66
Stage 1	133	133	-
Stage 2	843	959	-
Critical Hdwy	7.6	6.6	7
Critical Hdwy Stg 1	6.6	5.6	-
Critical Hdwy Stg 2	6.6	5.6	-
Follow-up Hdwy	3.55	4.05	3.35
Pot Cap-1 Maneuver	201	209	975
Stage 1	848	778	-
Stage 2	318	327	-
Platoon blocked, %			
Mov Cap-1 Maneuver	150	147	975
Mov Cap-2 Maneuver	150	147	-
Stage 1	600	774	-
Stage 2	218	232	-

Approach	SB
HCM Control Delay, s	12
HCM LOS	B

Minor Lane/Major Mvmt

Intersection	
Int Delay, s/veh	5

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR
Vol, veh/h	233	100	4	6	271	18	4	8	4
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Free	Free	Stop	Stop	Stop
RT Channelized	-	-	None	-	-	None	-	-	None
Storage Length	-	-	-	-	-	-	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-
Peak Hour Factor	90	90	90	90	90	90	90	90	90
Heavy Vehicles, %	4	4	4	4	4	4	2	2	2
Mvmt Flow	259	111	4	7	301	20	4	9	4

Major/Minor	Major1			Major2			Minor1		
Conflicting Flow All	321	0	0	116	0	0	798	965	58
Stage 1	-	-	-	-	-	-	631	631	-
Stage 2	-	-	-	-	-	-	167	334	-
Critical Hdwy	4.18	-	-	4.18	-	-	7.54	6.54	6.94
Critical Hdwy Stg 1	-	-	-	-	-	-	6.54	5.54	-
Critical Hdwy Stg 2	-	-	-	-	-	-	6.54	5.54	-
Follow-up Hdwy	2.24	-	-	2.24	-	-	3.52	4.02	3.32
Pot Cap-1 Maneuver	1221	-	-	1456	-	-	277	253	996
Stage 1	-	-	-	-	-	-	436	473	-
Stage 2	-	-	-	-	-	-	818	642	-
Platoon blocked, %		-	-		-	-			
Mov Cap-1 Maneuver	1221	-	-	1456	-	-	129	194	996
Mov Cap-2 Maneuver	-	-	-	-	-	-	129	194	-
Stage 1	-	-	-	-	-	-	337	366	-
Stage 2	-	-	-	-	-	-	467	638	-

Approach	EB	WB	NB
HCM Control Delay, s			23.7
HCM LOS			C

Minor Lane/Major Mvmt	NBLn1	EBL	EBT	EBR	WBL	WBT	WBR	SBLn1	SBLn2
Capacity (veh/h)	210	1221	-	-	1456	-	-	185	849
HCM Lane V/C Ratio	0.085	0.212	-	-	0.005	-	-	0.15	0.42
HCM Control Delay (s)	23.7	8.7	0.2	-	7.5	0	-	27.9	12.3
HCM Lane LOS	C	A	A	-	A	A	-	D	B
HCM 95th %tile Q(veh)	0	1	-	-	0	-	-	1	2

Intersection			
Int Delay, s/veh			

Movement	SBL	SBT	SBR
Vol, veh/h	19	6	321
Conflicting Peds, #/hr	0	0	0
Sign Control	Stop	Stop	Stop
RT Channelized	-	-	None
Storage Length	-	-	0
Veh in Median Storage, #	-	0	-
Grade, %	-	0	-
Peak Hour Factor	90	90	90
Heavy Vehicles, %	4	4	4
Mvmt Flow	21	7	357

Major/Minor	Minor2		
Conflicting Flow All	902	957	161
Stage 1	324	324	-
Stage 2	578	633	-
Critical Hdwy	7.58	6.58	6.98
Critical Hdwy Stg 1	6.58	5.58	-
Critical Hdwy Stg 2	6.58	5.58	-
Follow-up Hdwy	3.54	4.04	3.34
Pot Cap-1 Maneuver	230	253	849
Stage 1	657	643	-
Stage 2	464	467	-
Platoon blocked, %			
Mov Cap-1 Maneuver	182	194	849
Mov Cap-2 Maneuver	182	194	-
Stage 1	508	639	-
Stage 2	348	361	-

Approach	SB
HCM Control Delay, s	13.4
HCM LOS	B

Minor Lane/Major Mvmt

Intersection	
Int Delay, s/veh	4.5

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR
Vol, veh/h	22	4	202	5	5	4	104	47	7
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0
Sign Control	Stop	Stop	Stop	Stop	Stop	Stop	Free	Free	Free
RT Channelized	-	-	None	-	-	None	-	-	None
Storage Length	-	-	0	-	-	-	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-
Peak Hour Factor	90	90	90	90	90	90	90	90	90
Heavy Vehicles, %	5	5	5	2	2	2	3	3	3
Mvmt Flow	24	4	224	6	6	4	116	52	8

Major/Minor	Minor2			Minor1			Major1		
Conflicting Flow All	444	475	92	382	479	30	183	0	0
Stage 1	184	184	-	287	287	-	-	-	-
Stage 2	260	291	-	95	192	-	-	-	-
Critical Hdwy	7.6	6.6	7	7.54	6.54	6.94	4.16	-	-
Critical Hdwy Stg 1	6.6	5.6	-	6.54	5.54	-	-	-	-
Critical Hdwy Stg 2	6.6	5.6	-	6.54	5.54	-	-	-	-
Follow-up Hdwy	3.55	4.05	3.35	3.52	4.02	3.32	2.23	-	-
Pot Cap-1 Maneuver	490	480	938	551	484	1038	1382	-	-
Stage 1	791	739	-	696	673	-	-	-	-
Stage 2	714	663	-	901	740	-	-	-	-
Platoon blocked, %								-	-
Mov Cap-1 Maneuver	450	437	938	387	441	1038	1382	-	-
Mov Cap-2 Maneuver	450	437	-	387	441	-	-	-	-
Stage 1	722	737	-	635	614	-	-	-	-
Stage 2	643	605	-	679	738	-	-	-	-

Approach	EB	WB	NB
HCM Control Delay, s	10.4	12.5	
HCM LOS	B	B	

Minor Lane/Major Mvmt	NBL	NBT	NBR	EBLn1	EBLn2	WBLn1	SBL	SBT	SBR
Capacity (veh/h)	1382	-	-	448	938	498	1520	-	-
HCM Lane V/C Ratio	0.084	-	-	0.064	0.239	0.031	0.003	-	-
HCM Control Delay (s)	7.8	0.1	-	13.6	10	12.5	7.4	0	-
HCM Lane LOS	A	A	-	B	B	B	A	A	-
HCM 95th %tile Q(veh)	0	-	-	0	1	0	0	-	-

Intersection			
Int Delay, s/veh			

Movement	SBL	SBT	SBR
Vol, veh/h	4	151	14
Conflicting Peds, #/hr	0	0	0
Sign Control	Free	Free	Free
RT Channelized	-	-	None
Storage Length	-	-	-
Veh in Median Storage, #	-	0	-
Grade, %	-	0	-
Peak Hour Factor	90	90	90
Heavy Vehicles, %	5	5	5
Mvmt Flow	4	168	16

Major/Minor	Major2		
Conflicting Flow All	60	0	0
Stage 1	-	-	-
Stage 2	-	-	-
Critical Hdwy	4.2	-	-
Critical Hdwy Stg 1	-	-	-
Critical Hdwy Stg 2	-	-	-
Follow-up Hdwy	2.25	-	-
Pot Cap-1 Maneuver	1520	-	-
Stage 1	-	-	-
Stage 2	-	-	-
Platoon blocked, %		-	-
Mov Cap-1 Maneuver	1520	-	-
Mov Cap-2 Maneuver	-	-	-
Stage 1	-	-	-
Stage 2	-	-	-

Approach	SB
HCM Control Delay, s	
HCM LOS	

Minor Lane/Major Mvmt

Intersection	
Int Delay, s/veh	2.6

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR
Vol, veh/h	22	4	97	6	4	4	230	125	5
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0
Sign Control	Stop	Stop	Stop	Stop	Stop	Stop	Free	Free	Free
RT Channelized	-	-	None	-	-	None	-	-	None
Storage Length	-	-	0	-	-	-	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-
Peak Hour Factor	90	90	90	90	90	90	90	90	90
Heavy Vehicles, %	4	4	4	2	2	2	3	3	3
Mvmt Flow	24	4	108	7	4	4	256	139	6

Major/Minor	Minor2			Minor1			Major1		
Conflicting Flow All	685	758	62	695	789	72	124	0	0
Stage 1	102	102	-	653	653	-	-	-	-
Stage 2	583	656	-	42	136	-	-	-	-
Critical Hdwy	7.58	6.58	6.98	7.54	6.54	6.94	4.16	-	-
Critical Hdwy Stg 1	6.58	5.58	-	6.54	5.54	-	-	-	-
Critical Hdwy Stg 2	6.58	5.58	-	6.54	5.54	-	-	-	-
Follow-up Hdwy	3.54	4.04	3.34	3.52	4.02	3.32	2.23	-	-
Pot Cap-1 Maneuver	330	331	984	329	321	975	1453	-	-
Stage 1	887	805	-	423	462	-	-	-	-
Stage 2	460	455	-	967	783	-	-	-	-
Platoon blocked, %								-	-
Mov Cap-1 Maneuver	275	266	984	246	258	975	1453	-	-
Mov Cap-2 Maneuver	275	266	-	246	258	-	-	-	-
Stage 1	717	801	-	342	373	-	-	-	-
Stage 2	366	368	-	852	779	-	-	-	-

Approach	EB	WB	NB
HCM Control Delay, s	11.3	16.9	
HCM LOS	B	C	

Minor Lane/Major Mvmt	NBL	NBT	NBR	EBLn1	EBLn2	WBLn1	SBL	SBT	SBR
Capacity (veh/h)	1453	-	-	274	984	318	1422	-	-
HCM Lane V/C Ratio	0.176	-	-	0.105	0.11	0.049	0.004	-	-
HCM Control Delay (s)	8	0.2	-	19.7	9.1	16.9	7.5	0	-
HCM Lane LOS	A	A	-	C	A	C	A	A	-
HCM 95th %tile Q(veh)	1	-	-	0	0	0	0	-	-

Intersection			
Int Delay, s/veh			

Movement	SBL	SBT	SBR
Vol, veh/h	5	51	61
Conflicting Peds, #/hr	0	0	0
Sign Control	Free	Free	Free
RT Channelized	-	-	None
Storage Length	-	-	-
Veh in Median Storage, #	-	0	-
Grade, %	-	0	-
Peak Hour Factor	90	90	90
Heavy Vehicles, %	4	4	4
Mvmt Flow	6	57	68

Major/Minor	Major2		
Conflicting Flow All	144	0	0
Stage 1	-	-	-
Stage 2	-	-	-
Critical Hdwy	4.18	-	-
Critical Hdwy Stg 1	-	-	-
Critical Hdwy Stg 2	-	-	-
Follow-up Hdwy	2.24	-	-
Pot Cap-1 Maneuver	1422	-	-
Stage 1	-	-	-
Stage 2	-	-	-
Platoon blocked, %		-	-
Mov Cap-1 Maneuver	1422	-	-
Mov Cap-2 Maneuver	-	-	-
Stage 1	-	-	-
Stage 2	-	-	-

Approach	SB
HCM Control Delay, s	
HCM LOS	

Minor Lane/Major Mvmt

Intersection	
Intersection Delay, s/veh	16.4
Intersection LOS	C

Movement	EBU	EBL	EBT	EBR	WBU	WBL	WBT	WBR	NBU	NBL	NBT	NBR
Vol, veh/h	0	28	7	91	0	12	6	39	0	163	127	11
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Heavy Vehicles, %	2	2	2	2	2	3	3	3	2	5	5	5
Mvmt Flow	0	31	8	101	0	13	7	43	0	181	141	12
Number of Lanes	0	0	1	0	0	0	1	1	0	0	1	1

Approach	EB	WB	NB
Opposing Approach	WB	EB	SB
Opposing Lanes	2	1	1
Conflicting Approach Left	SB	NB	EB
Conflicting Lanes Left	1	2	1
Conflicting Approach Right	NB	SB	WB
Conflicting Lanes Right	2	1	2
HCM Control Delay	11.6	9.9	15.5
HCM LOS	B	A	C

Lane	NBLn1	NBLn2	EBLn1	WBLn1	WBLn2	SBLn1
Vol Left, %	56%	0%	22%	67%	0%	32%
Vol Thru, %	44%	0%	6%	33%	0%	46%
Vol Right, %	0%	100%	72%	0%	100%	22%
Sign Control	Stop	Stop	Stop	Stop	Stop	Stop
Traffic Vol by Lane	290	11	126	18	39	379
LT Vol	127	0	7	6	0	176
Through Vol	0	11	91	0	39	82
RT Vol	163	0	28	12	0	121
Lane Flow Rate	322	12	140	20	43	421
Geometry Grp	7	7	6	7	7	6
Degree of Util (X)	0.543	0.017	0.25	0.041	0.076	0.669
Departure Headway (Hd)	6.07	5.077	6.425	7.347	6.291	5.721
Convergence, Y/N	Yes	Yes	Yes	Yes	Yes	Yes
Cap	593	704	557	486	567	632
Service Time	3.809	2.815	4.48	5.108	4.052	3.758
HCM Lane V/C Ratio	0.543	0.017	0.251	0.041	0.076	0.666
HCM Control Delay	15.8	7.9	11.6	10.4	9.6	19.6
HCM Lane LOS	C	A	B	B	A	C
HCM 95th-tile Q	3.3	0.1	1	0.1	0.2	5.1

Intersection	
Intersection Delay, s/veh	
Intersection LOS	

Movement	SBU	SBL	SBT	SBR
Vol, veh/h	0	121	176	82
Peak Hour Factor	0.90	0.90	0.90	0.90
Heavy Vehicles, %	2	4	4	4
Mvmt Flow	0	134	196	91
Number of Lanes	0	0	1	0

Approach	SB
Opposing Approach	NB
Opposing Lanes	2
Conflicting Approach Left	WB
Conflicting Lanes Left	2
Conflicting Approach Right	EB
Conflicting Lanes Right	1
HCM Control Delay	19.6
HCM LOS	C

Lane

Intersection	
Intersection Delay, s/veh	14.9
Intersection LOS	B

Movement	EBU	EBL	EBT	EBR	WBU	WBL	WBT	WBR	NBU	NBL	NBT	NBR
Vol, veh/h	0	53	9	158	0	7	8	152	0	115	165	14
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Heavy Vehicles, %	2	2	2	2	2	2	2	2	2	4	4	4
Mvmt Flow	0	59	10	176	0	8	9	169	0	128	183	16
Number of Lanes	0	0	1	0	0	0	1	1	0	0	1	1

Approach	EB	WB	NB
Opposing Approach	WB	EB	SB
Opposing Lanes	2	1	1
Conflicting Approach Left	SB	NB	EB
Conflicting Lanes Left	1	2	1
Conflicting Approach Right	NB	SB	WB
Conflicting Lanes Right	2	1	2
HCM Control Delay	14.3	11.4	17.3
HCM LOS	B	B	C

Lane	NBLn1	NBLn2	EBLn1	WBLn1	WBLn2	SBLn1
Vol Left, %	41%	0%	24%	47%	0%	16%
Vol Thru, %	59%	0%	4%	53%	0%	67%
Vol Right, %	0%	100%	72%	0%	100%	16%
Sign Control	Stop	Stop	Stop	Stop	Stop	Stop
Traffic Vol by Lane	280	14	220	15	152	226
LT Vol	165	0	9	8	0	152
Through Vol	0	14	158	0	152	37
RT Vol	115	0	53	7	0	37
Lane Flow Rate	311	16	244	17	169	251
Geometry Grp	7	7	6	7	7	6
Degree of Util (X)	0.567	0.024	0.433	0.033	0.293	0.454
Departure Headway (Hd)	6.564	5.643	6.481	7.202	6.248	6.615
Convergence, Y/N	Yes	Yes	Yes	Yes	Yes	Yes
Cap	544	627	560	500	579	547
Service Time	4.361	3.44	4.481	4.902	3.948	4.615
HCM Lane V/C Ratio	0.572	0.026	0.436	0.034	0.292	0.459
HCM Control Delay	17.7	8.6	14.3	10.1	11.5	15
HCM Lane LOS	C	A	B	B	B	B
HCM 95th-tile Q	3.5	0.1	2.2	0.1	1.2	2.3

Intersection	
Intersection Delay, s/veh	
Intersection LOS	

Movement	SBU	SBL	SBT	SBR
Vol, veh/h	0	37	152	37
Peak Hour Factor	0.90	0.90	0.90	0.90
Heavy Vehicles, %	2	3	3	3
Mvmt Flow	0	41	169	41
Number of Lanes	0	0	1	0

Approach	SB
Opposing Approach	NB
Opposing Lanes	2
Conflicting Approach Left	WB
Conflicting Lanes Left	2
Conflicting Approach Right	EB
Conflicting Lanes Right	1
HCM Control Delay	15
HCM LOS	B

Lane

Intersection	
Int Delay, s/veh	1.3

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Vol, veh/h	7	20	166	7	62	354
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	0	-	-	-	-	-
Veh in Median Storage, #	0	-	0	-	-	0
Grade, %	0	-	0	-	-	0
Peak Hour Factor	90	90	90	90	90	90
Heavy Vehicles, %	16	16	4	4	6	6
Mvmt Flow	8	22	184	8	69	393

Major/Minor	Minor1		Major1		Major2	
Conflicting Flow All	719	188	0	0	192	0
Stage 1	188	-	-	-	-	-
Stage 2	531	-	-	-	-	-
Critical Hdwy	6.56	6.36	-	-	4.16	-
Critical Hdwy Stg 1	5.56	-	-	-	-	-
Critical Hdwy Stg 2	5.56	-	-	-	-	-
Follow-up Hdwy	3.644	3.444	-	-	2.254	-
Pot Cap-1 Maneuver	375	819	-	-	1358	-
Stage 1	812	-	-	-	-	-
Stage 2	562	-	-	-	-	-
Platoon blocked, %			-	-		-
Mov Cap-1 Maneuver	351	819	-	-	1358	-
Mov Cap-2 Maneuver	351	-	-	-	-	-
Stage 1	812	-	-	-	-	-
Stage 2	525	-	-	-	-	-

Approach	WB	NB	SB
HCM Control Delay, s	11.2		1.2
HCM LOS	B		

Minor Lane/Major Mvmt	NBT	NBR	WBLn1	SBL	SBT
Capacity (veh/h)	-	-	609	1358	-
HCM Lane V/C Ratio	-	-	0.049	0.051	-
HCM Control Delay (s)	-	-	11.2	7.8	0
HCM Lane LOS	-	-	B	A	A
HCM 95th %tile Q(veh)	-	-	0	0	-

Intersection	
Int Delay, s/veh	1.9

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Vol, veh/h	9	80	375	9	21	185
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	0	-	-	-	-	-
Veh in Median Storage, #	0	-	0	-	-	0
Grade, %	0	-	0	-	-	0
Peak Hour Factor	90	90	90	90	90	90
Heavy Vehicles, %	10	10	3	3	5	5
Mvmt Flow	10	89	417	10	23	206

Major/Minor	Minor1		Major1		Major2	
Conflicting Flow All	674	422	0	0	427	0
Stage 1	422	-	-	-	-	-
Stage 2	252	-	-	-	-	-
Critical Hdwy	6.5	6.3	-	-	4.15	-
Critical Hdwy Stg 1	5.5	-	-	-	-	-
Critical Hdwy Stg 2	5.5	-	-	-	-	-
Follow-up Hdwy	3.59	3.39	-	-	2.245	-
Pot Cap-1 Maneuver	408	615	-	-	1116	-
Stage 1	645	-	-	-	-	-
Stage 2	772	-	-	-	-	-
Platoon blocked, %			-	-		-
Mov Cap-1 Maneuver	399	615	-	-	1116	-
Mov Cap-2 Maneuver	399	-	-	-	-	-
Stage 1	645	-	-	-	-	-
Stage 2	754	-	-	-	-	-

Approach	WB	NB	SB
HCM Control Delay, s	12.4		0.8
HCM LOS	B		

Minor Lane/Major Mvmt	NBT	NBR	WBLn1	SBL	SBT
Capacity (veh/h)	-	-	583	1116	-
HCM Lane V/C Ratio	-	-	0.17	0.021	-
HCM Control Delay (s)	-	-	12.4	8.3	0
HCM Lane LOS	-	-	B	A	A
HCM 95th %tile Q(veh)	-	-	1	0	-

Intersection	
Int Delay, s/veh	1.1

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Vol, veh/h	22	176	130	96	384	93
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	Free	-	None	-	None
Storage Length	0	100	-	-	0	-
Veh in Median Storage, #	0	-	0	-	-	0
Grade, %	0	-	0	-	-	0
Peak Hour Factor	90	90	90	90	90	90
Heavy Vehicles, %	6	6	2	2	7	7
Mvmt Flow	24	196	144	107	427	103

Major/Minor	Minor1		Major1		Major2	
Conflicting Flow All	1155	-	0	0	251	0
Stage 1	198	-	-	-	-	-
Stage 2	957	-	-	-	-	-
Critical Hdwy	6.46	-	-	-	4.17	-
Critical Hdwy Stg 1	5.46	-	-	-	-	-
Critical Hdwy Stg 2	5.46	-	-	-	-	-
Follow-up Hdwy	3.554	-	-	-	2.263	-
Pot Cap-1 Maneuver	214	0	-	-	1286	-
Stage 1	826	0	-	-	-	-
Stage 2	367	0	-	-	-	-
Platoon blocked, %			-	-		-
Mov Cap-1 Maneuver	143	-	-	-	1286	-
Mov Cap-2 Maneuver	143	-	-	-	-	-
Stage 1	826	-	-	-	-	-
Stage 2	245	-	-	-	-	-

Approach	WB	NB	SB
HCM Control Delay, s	35.3		
HCM LOS	E		

Minor Lane/Major Mvmt	NBT	NBR	WBLn1	WBLn2	SBL	SBT
Capacity (veh/h)	-	-	143	-	1286	-
HCM Lane V/C Ratio	-	-	0.171	-	0.332	-
HCM Control Delay (s)	-	-	35.3	0	9.2	-
HCM Lane LOS	-	-	E	A	A	-
HCM 95th %tile Q(veh)	-	-	1	-	1	-

Intersection	
Int Delay, s/veh	1.4

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Vol, veh/h	43	457	78	54	133	130
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	Free	-	None	-	None
Storage Length	0	100	-	-	0	-
Veh in Median Storage, #	0	-	0	-	-	0
Grade, %	0	-	0	-	-	0
Peak Hour Factor	90	90	90	90	90	90
Heavy Vehicles, %	5	5	2	2	5	5
Mvmt Flow	48	508	87	60	148	144

Major/Minor	Minor1		Major1		Major2	
Conflicting Flow All	557	-	0	0	147	0
Stage 1	117	-	-	-	-	-
Stage 2	440	-	-	-	-	-
Critical Hdwy	6.45	-	-	-	4.15	-
Critical Hdwy Stg 1	5.45	-	-	-	-	-
Critical Hdwy Stg 2	5.45	-	-	-	-	-
Follow-up Hdwy	3.545	-	-	-	2.245	-
Pot Cap-1 Maneuver	486	0	-	-	1417	-
Stage 1	901	0	-	-	-	-
Stage 2	643	0	-	-	-	-
Platoon blocked, %			-	-		-
Mov Cap-1 Maneuver	435	-	-	-	1417	-
Mov Cap-2 Maneuver	435	-	-	-	-	-
Stage 1	901	-	-	-	-	-
Stage 2	576	-	-	-	-	-

Approach	WB	NB	SB
HCM Control Delay, s	14.3		
HCM LOS	B		

Minor Lane/Major Mvmt	NBT	NBR	WBLn1	WBLn2	SBL	SBT
Capacity (veh/h)	-	-	435	-	1417	-
HCM Lane V/C Ratio	-	-	0.11	-	0.104	-
HCM Control Delay (s)	-	-	14.3	0	7.8	-
HCM Lane LOS	-	-	B	A	A	-
HCM 95th %tile Q(veh)	-	-	0	-	0	-

Intersection	
Int Delay, s/veh	2.2

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Vol, veh/h	64	56	37	246	403	32
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	0	-	150	-	-	-
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	90	90	90	90	90	90
Heavy Vehicles, %	2	2	7	7	11	11
Mvmt Flow	71	62	41	273	448	36

Major/Minor	Minor2		Major1		Major2	
Conflicting Flow All	685	242	483	0	-	0
Stage 1	466	-	-	-	-	-
Stage 2	219	-	-	-	-	-
Critical Hdwy	6.84	6.94	4.24	-	-	-
Critical Hdwy Stg 1	5.84	-	-	-	-	-
Critical Hdwy Stg 2	5.84	-	-	-	-	-
Follow-up Hdwy	3.52	3.32	2.27	-	-	-
Pot Cap-1 Maneuver	382	759	1042	-	-	-
Stage 1	598	-	-	-	-	-
Stage 2	796	-	-	-	-	-
Platoon blocked, %				-	-	-
Mov Cap-1 Maneuver	367	759	1042	-	-	-
Mov Cap-2 Maneuver	367	-	-	-	-	-
Stage 1	598	-	-	-	-	-
Stage 2	765	-	-	-	-	-

Approach	EB	NB	SB
HCM Control Delay, s	15.2		
HCM LOS	C		

Minor Lane/Major Mvmt	NBL	NBT	EBLn1	SBT	SBR
Capacity (veh/h)	1042	-	484	-	-
HCM Lane V/C Ratio	0.039	-	0.275	-	-
HCM Control Delay (s)	8.6	-	15.2	-	-
HCM Lane LOS	A	-	C	-	-
HCM 95th %tile Q(veh)	0	-	1	-	-

Intersection	
Int Delay, s/veh	1.7

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Vol, veh/h	60	48	81	521	207	72
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	0	-	150	-	-	-
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	90	90	90	90	90	90
Heavy Vehicles, %	2	2	5	5	9	9
Mvmt Flow	67	53	90	579	230	80

Major/Minor	Minor2		Major1		Major2	
Conflicting Flow All	739	155	310	0	-	0
Stage 1	270	-	-	-	-	-
Stage 2	469	-	-	-	-	-
Critical Hdwy	6.84	6.94	4.2	-	-	-
Critical Hdwy Stg 1	5.84	-	-	-	-	-
Critical Hdwy Stg 2	5.84	-	-	-	-	-
Follow-up Hdwy	3.52	3.32	2.25	-	-	-
Pot Cap-1 Maneuver	353	863	1226	-	-	-
Stage 1	751	-	-	-	-	-
Stage 2	596	-	-	-	-	-
Platoon blocked, %				-	-	-
Mov Cap-1 Maneuver	327	863	1226	-	-	-
Mov Cap-2 Maneuver	327	-	-	-	-	-
Stage 1	751	-	-	-	-	-
Stage 2	552	-	-	-	-	-

Approach	EB	NB	SB
HCM Control Delay, s	15.8		
HCM LOS	C		

Minor Lane/Major Mvmt	NBL	NBT	EBLn1	SBT	SBR
Capacity (veh/h)	1226	-	452	-	-
HCM Lane V/C Ratio	0.073	-	0.265	-	-
HCM Control Delay (s)	8.2	-	15.8	-	-
HCM Lane LOS	A	-	C	-	-
HCM 95th %tile Q(veh)	0	-	1	-	-

Intersection	
Int Delay, s/veh	17.4

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Vol, veh/h	416	258	0	346	220	0
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	350	0	-	-	-	-
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	90	90	90	90	90	90
Heavy Vehicles, %	13	13	11	11	15	15
Mvmt Flow	462	287	0	384	244	0

Major/Minor	Minor2		Major1		Major2	
Conflicting Flow All	436	122	244	0	-	0
Stage 1	244	-	-	-	-	-
Stage 2	192	-	-	-	-	-
Critical Hdwy	7.06	7.16	4.32	-	-	-
Critical Hdwy Stg 1	6.06	-	-	-	-	-
Critical Hdwy Stg 2	6.06	-	-	-	-	-
Follow-up Hdwy	3.63	3.43	2.31	-	-	-
Pot Cap-1 Maneuver	521	872	1256	-	-	-
Stage 1	742	-	-	-	-	-
Stage 2	790	-	-	-	-	-
Platoon blocked, %				-	-	-
Mov Cap-1 Maneuver	521	872	1256	-	-	-
Mov Cap-2 Maneuver	521	-	-	-	-	-
Stage 1	742	-	-	-	-	-
Stage 2	790	-	-	-	-	-

Approach	EB	NB	SB
HCM Control Delay, s	32		
HCM LOS	D		

Minor Lane/Major Mvmt	NBL	NBT	EBLn1	EBLn2	SBT	SBR
Capacity (veh/h)	1256	-	521	872	-	-
HCM Lane V/C Ratio	-	-	0.887	0.329	-	-
HCM Control Delay (s)	0	-	44.9	11.1	-	-
HCM Lane LOS	A	-	E	B	-	-
HCM 95th %tile Q(veh)	0	-	10	1	-	-

Intersection	
Int Delay, s/veh	2.8

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Vol, veh/h	100	81	0	548	178	0
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	350	0	-	-	-	-
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	90	90	90	90	90	90
Heavy Vehicles, %	42	42	9	9	15	15
Mvmt Flow	111	90	0	609	198	0

Major/Minor	Minor2		Major1		Major2	
Conflicting Flow All	502	99	198	0	-	0
Stage 1	198	-	-	-	-	-
Stage 2	304	-	-	-	-	-
Critical Hdwy	7.64	7.74	4.28	-	-	-
Critical Hdwy Stg 1	6.64	-	-	-	-	-
Critical Hdwy Stg 2	6.64	-	-	-	-	-
Follow-up Hdwy	3.92	3.72	2.29	-	-	-
Pot Cap-1 Maneuver	411	823	1322	-	-	-
Stage 1	709	-	-	-	-	-
Stage 2	616	-	-	-	-	-
Platoon blocked, %				-	-	-
Mov Cap-1 Maneuver	411	823	1322	-	-	-
Mov Cap-2 Maneuver	411	-	-	-	-	-
Stage 1	709	-	-	-	-	-
Stage 2	616	-	-	-	-	-

Approach	EB	NB	SB
HCM Control Delay, s	13.8		
HCM LOS	B		

Minor Lane/Major Mvmt	NBL	NBT	EBLn1	EBLn2	SBT	SBR
Capacity (veh/h)	1322	-	411	823	-	-
HCM Lane V/C Ratio	-	-	0.27	0.109	-	-
HCM Control Delay (s)	0	-	17	9.9	-	-
HCM Lane LOS	A	-	C	A	-	-
HCM 95th %tile Q(veh)	0	-	1	0	-	-

Intersection	
Int Delay, s/veh	0

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Vol, veh/h	0	0	75	687	220	57
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	0	-	225	-	-	325
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	90	90	90	90	90	90
Heavy Vehicles, %	2	2	15	15	25	25
Mvmt Flow	0	0	83	763	244	63

Major/Minor	Minor2		Major1		Major2	
Conflicting Flow All	792	122	244	0	-	0
Stage 1	244	-	-	-	-	-
Stage 2	548	-	-	-	-	-
Critical Hdwy	6.84	6.94	4.4	-	-	-
Critical Hdwy Stg 1	5.84	-	-	-	-	-
Critical Hdwy Stg 2	5.84	-	-	-	-	-
Follow-up Hdwy	3.52	3.32	2.35	-	-	-
Pot Cap-1 Maneuver	326	906	1230	-	-	-
Stage 1	774	-	-	-	-	-
Stage 2	543	-	-	-	-	-
Platoon blocked, %				-	-	-
Mov Cap-1 Maneuver	304	906	1230	-	-	-
Mov Cap-2 Maneuver	304	-	-	-	-	-
Stage 1	774	-	-	-	-	-
Stage 2	506	-	-	-	-	-

Approach	EB	NB	SB
HCM Control Delay, s	0		
HCM LOS	A		

Minor Lane/Major Mvmt	NBL	NBT	EBLn1	SBT	SBR
Capacity (veh/h)	1230	-	-	-	-
HCM Lane V/C Ratio	0.068	-	-	-	-
HCM Control Delay (s)	8.1	-	0	-	-
HCM Lane LOS	A	-	A	-	-
HCM 95th %tile Q(veh)	0	-	-	-	-

Intersection	
Int Delay, s/veh	0

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Vol, veh/h	0	0	294	354	178	546
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	0	-	225	-	-	325
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	90	90	90	90	90	90
Heavy Vehicles, %	2	2	15	15	19	19
Mvmt Flow	0	0	327	393	198	607

Major/Minor	Minor2		Major1		Major2	
Conflicting Flow All	1048	99	198	0	-	0
Stage 1	198	-	-	-	-	-
Stage 2	850	-	-	-	-	-
Critical Hdwy	6.84	6.94	4.4	-	-	-
Critical Hdwy Stg 1	5.84	-	-	-	-	-
Critical Hdwy Stg 2	5.84	-	-	-	-	-
Follow-up Hdwy	3.52	3.32	2.35	-	-	-
Pot Cap-1 Maneuver	223	937	1282	-	-	-
Stage 1	816	-	-	-	-	-
Stage 2	379	-	-	-	-	-
Platoon blocked, %				-	-	-
Mov Cap-1 Maneuver	166	937	1282	-	-	-
Mov Cap-2 Maneuver	166	-	-	-	-	-
Stage 1	816	-	-	-	-	-
Stage 2	282	-	-	-	-	-

Approach	EB	NB	SB
HCM Control Delay, s	0		
HCM LOS	A		

Minor Lane/Major Mvmt	NBL	NBT	EBLn1	SBT	SBR
Capacity (veh/h)	1282	-	-	-	-
HCM Lane V/C Ratio	0.255	-	-	-	-
HCM Control Delay (s)	8.8	-	0	-	-
HCM Lane LOS	A	-	A	-	-
HCM 95th %tile Q(veh)	1	-	-	-	-

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Volume (veh/h)	413	56	171	395	825	930
Number	3	18	1	6	2	12
Initial Q (Qb), veh	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00	1.00	1.00			1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1776	1900	1863	1863	1845	1845
Adj Flow Rate, veh/h	517	0	190	439	917	1033
Adj No. of Lanes	2	1	1	2	2	1
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90
Percent Heavy Veh, %	7	0	2	2	3	3
Cap, veh/h	590	282	194	2581	2556	1144
Arrive On Green	0.17	0.00	0.73	0.73	0.49	0.49
Sat Flow, veh/h	3382	1615	225	3632	3597	1568
Grp Volume(v), veh/h	517	0	190	439	917	1033
Grp Sat Flow(s),veh/h/ln	1691	1615	225	1770	1752	1568
Q Serve(g_s), s	16.2	0.0	61.5	4.2	17.6	65.4
Cycle Q Clear(g_c), s	16.2	0.0	79.1	4.2	17.6	65.4
Prop In Lane	1.00	1.00	1.00			1.00
Lane Grp Cap(c), veh/h	590	282	194	2581	2556	1144
V/C Ratio(X)	0.88	0.00	0.98	0.17	0.36	0.90
Avail Cap(c_a), veh/h	686	328	194	2581	2556	1144
HCM Platoon Ratio	1.00	1.00	1.00	1.00	0.67	0.67
Upstream Filter(I)	1.00	0.00	1.00	1.00	0.13	0.13
Uniform Delay (d), s/veh	43.6	0.0	33.6	4.5	12.0	24.2
Incr Delay (d2), s/veh	11.1	0.0	59.4	0.1	0.1	1.9
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	8.4	0.0	8.8	2.1	8.5	28.9
LnGrp Delay(d),s/veh	54.8	0.0	92.9	4.7	12.1	26.1
LnGrp LOS	D		F	A	B	C
Approach Vol, veh/h	517			629	1950	
Approach Delay, s/veh	54.8			31.3	19.5	
Approach LOS	D			C	B	

Timer	1	2	3	4	5	6	7	8
Assigned Phs		2				6		8
Phs Duration (G+Y+Rc), s		85.1				85.1		24.9
Change Period (Y+Rc), s		6.0				6.0		6.0
Max Green Setting (Gmax), s		76.0				76.0		22.0
Max Q Clear Time (g_c+I1), s		67.4				81.1		18.2
Green Ext Time (p_c), s		7.9				0.0		0.7

Intersection Summary	
HCM 2010 Ctrl Delay	27.8
HCM 2010 LOS	C

Notes

User approved volume balancing among the lanes for turning movement.

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Volume (veh/h)	590	98	179	581	660	605
Number	3	18	1	6	2	12
Initial Q (Qb), veh	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00	1.00	1.00			1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1827	1900	1863	1863	1845	1845
Adj Flow Rate, veh/h	758	0	199	646	733	672
Adj No. of Lanes	2	1	1	2	2	1
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90
Percent Heavy Veh, %	4	0	2	2	3	3
Cap, veh/h	864	401	314	2388	2365	1058
Arrive On Green	0.25	0.00	0.67	0.67	0.90	0.90
Sat Flow, veh/h	3480	1615	382	3632	3597	1568
Grp Volume(v), veh/h	758	0	199	646	733	672
Grp Sat Flow(s),veh/h/ln	1740	1615	382	1770	1752	1568
Q Serve(g_s), s	22.2	0.0	41.0	7.7	3.2	10.9
Cycle Q Clear(g_c), s	22.2	0.0	44.2	7.7	3.2	10.9
Prop In Lane	1.00	1.00	1.00			1.00
Lane Grp Cap(c), veh/h	864	401	314	2388	2365	1058
V/C Ratio(X)	0.88	0.00	0.63	0.27	0.31	0.64
Avail Cap(c_a), veh/h	1114	517	314	2388	2365	1058
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.33	1.33
Upstream Filter(I)	1.00	0.00	1.00	1.00	0.50	0.50
Uniform Delay (d), s/veh	38.4	0.0	14.0	6.9	1.9	2.3
Incr Delay (d2), s/veh	6.6	0.0	9.4	0.3	0.2	1.5
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	11.4	0.0	5.1	3.9	1.5	4.8
LnGrp Delay(d),s/veh	45.0	0.0	23.4	7.2	2.1	3.8
LnGrp LOS	D		C	A	A	A
Approach Vol, veh/h	758			845	1405	
Approach Delay, s/veh	45.0			11.0	2.9	
Approach LOS	D			B	A	

Timer	1	2	3	4	5	6	7	8
Assigned Phs		2				6		8
Phs Duration (G+Y+Rc), s		77.6				77.6		32.4
Change Period (Y+Rc), s		6.0				6.0		6.0
Max Green Setting (Gmax), s		64.0				64.0		34.0
Max Q Clear Time (g_c+I1), s		12.9				46.2		24.2
Green Ext Time (p_c), s		26.5				13.4		2.1

Intersection Summary	
HCM 2010 Ctrl Delay	15.8
HCM 2010 LOS	B

Notes

User approved volume balancing among the lanes for turning movement.

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Volume (veh/h)	555	318	96	712	1437	613
Number	3	18	1	6	2	12
Initial Q (Qb), veh	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00	1.00	1.00			1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1712	1900	1845	1845	1810	1810
Adj Flow Rate, veh/h	617	0	107	791	1597	681
Adj No. of Lanes	2	1	1	2	2	1
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90
Percent Heavy Veh, %	11	0	3	3	5	5
Cap, veh/h	712	353	247	2473	1939	868
Arrive On Green	0.22	0.00	0.17	1.00	0.56	0.56
Sat Flow, veh/h	3260	1615	1757	3597	3529	1538
Grp Volume(v), veh/h	617	0	107	791	1597	681
Grp Sat Flow(s),veh/h/ln	1630	1615	1757	1752	1719	1538
Q Serve(g_s), s	19.4	0.0	2.2	0.0	40.1	36.7
Cycle Q Clear(g_c), s	19.4	0.0	2.2	0.0	40.1	36.7
Prop In Lane	1.00	1.00	1.00			1.00
Lane Grp Cap(c), veh/h	712	353	247	2473	1939	868
V/C Ratio(X)	0.87	0.00	0.43	0.32	0.82	0.78
Avail Cap(c_a), veh/h	953	472	247	2473	1939	868
HCM Platoon Ratio	1.00	1.00	2.00	2.00	1.00	1.00
Upstream Filter(I)	1.00	0.00	0.83	0.83	1.00	1.00
Uniform Delay (d), s/veh	40.0	0.0	19.2	0.0	18.8	18.1
Incr Delay (d2), s/veh	6.6	0.0	1.0	0.3	4.1	7.1
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	9.4	0.0	1.7	0.1	20.0	17.2
LnGrp Delay(d),s/veh	46.6	0.0	20.2	0.3	22.9	25.1
LnGrp LOS	D		C	A	C	C
Approach Vol, veh/h	617			898	2278	
Approach Delay, s/veh	46.6			2.7	23.6	
Approach LOS	D			A	C	

Timer	1	2	3	4	5	6	7	8
Assigned Phs	1	2				6		8
Phs Duration (G+Y+Rc), s	15.0	65.8				80.8		29.2
Change Period (Y+Rc), s	6.0	6.0				6.0		6.0
Max Green Setting (Gmax), s	9.0	52.0				67.0		31.0
Max Q Clear Time (g_c+I1), s	4.2	42.1				2.0		21.4
Green Ext Time (p_c), s	0.1	9.1				43.8		1.8

Intersection Summary	
HCM 2010 Ctrl Delay	22.4
HCM 2010 LOS	C

Notes

User approved volume balancing among the lanes for turning movement.

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Volume (veh/h)	776	250	66	1105	1015	513
Number	3	18	1	6	2	12
Initial Q (Qb), veh	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00	1.00	1.00			1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1759	1900	1845	1845	1827	1827
Adj Flow Rate, veh/h	862	0	73	1228	1128	570
Adj No. of Lanes	2	1	1	2	2	1
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90
Percent Heavy Veh, %	8	0	3	3	4	4
Cap, veh/h	985	475	295	2261	1740	779
Arrive On Green	0.29	0.00	0.11	0.86	0.50	0.50
Sat Flow, veh/h	3351	1615	1757	3597	3563	1553
Grp Volume(v), veh/h	862	0	73	1228	1128	570
Grp Sat Flow(s),veh/h/ln	1675	1615	1757	1752	1736	1553
Q Serve(g_s), s	25.5	0.0	1.7	9.7	25.0	30.2
Cycle Q Clear(g_c), s	25.5	0.0	1.7	9.7	25.0	30.2
Prop In Lane	1.00	1.00	1.00			1.00
Lane Grp Cap(c), veh/h	985	475	295	2261	1740	779
V/C Ratio(X)	0.87	0.00	0.25	0.54	0.65	0.73
Avail Cap(c_a), veh/h	1349	650	295	2261	1740	779
HCM Platoon Ratio	1.00	1.00	1.33	1.33	1.00	1.00
Upstream Filter(I)	1.00	0.00	0.78	0.78	1.00	1.00
Uniform Delay (d), s/veh	35.0	0.0	12.7	3.3	19.2	20.5
Incr Delay (d2), s/veh	5.1	0.0	0.3	0.7	1.9	6.0
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	12.4	0.0	0.9	4.6	12.4	14.1
LnGrp Delay(d),s/veh	40.1	0.0	13.0	4.1	21.1	26.5
LnGrp LOS	D		B	A	C	C
Approach Vol, veh/h	862			1301	1698	
Approach Delay, s/veh	40.1			4.6	22.9	
Approach LOS	D			A	C	

Timer	1	2	3	4	5	6	7	8
Assigned Phs	1	2				6		8
Phs Duration (G+Y+Rc), s	15.0	58.3				73.3		36.7
Change Period (Y+Rc), s	6.0	6.0				6.0		6.0
Max Green Setting (Gmax), s	9.0	41.0				56.0		42.0
Max Q Clear Time (g_c+I1), s	3.7	32.2				11.7		27.5
Green Ext Time (p_c), s	0.1	8.0				31.5		3.2

Intersection Summary	
HCM 2010 Ctrl Delay	20.6
HCM 2010 LOS	C

Notes

User approved volume balancing among the lanes for turning movement.

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	31	833	235	29	710	232	54	7	116	14	5	62
Number	1	6	16	5	2	12	7	4	14	3	8	18
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1759	1759	1900	1827	1827	1827	1900	1792	1792	1845	1845	1900
Adj Flow Rate, veh/h	34	926	261	32	789	258	60	8	129	16	6	69
Adj No. of Lanes	1	2	0	1	2	1	0	1	1	1	1	0
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Percent Heavy Veh, %	8	8	8	4	4	4	6	6	6	3	3	3
Cap, veh/h	349	1558	438	278	2097	938	313	36	344	285	29	330
Arrive On Green	0.60	0.60	0.60	0.60	0.60	0.60	0.23	0.23	0.23	0.23	0.23	0.23
Sat Flow, veh/h	507	2578	725	461	3471	1553	963	158	1524	1235	127	1460
Grp Volume(v), veh/h	34	600	587	32	789	258	68	0	129	16	0	75
Grp Sat Flow(s),veh/h/ln	507	1671	1631	461	1736	1553	1121	0	1524	1235	0	1587
Q Serve(g_s), s	2.6	15.6	15.7	3.3	8.2	5.6	2.7	0.0	5.1	0.8	0.0	2.7
Cycle Q Clear(g_c), s	10.8	15.6	15.7	19.0	8.2	5.6	5.5	0.0	5.1	6.2	0.0	2.7
Prop In Lane	1.00		0.44	1.00		1.00	0.88		1.00	1.00		0.92
Lane Grp Cap(c), veh/h	349	1010	986	278	2097	938	349	0	344	285	0	358
V/C Ratio(X)	0.10	0.59	0.60	0.12	0.38	0.27	0.19	0.00	0.37	0.06	0.00	0.21
Avail Cap(c_a), veh/h	459	1373	1340	378	2851	1276	425	0	432	356	0	450
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.00	1.00	1.00	0.00	1.00
Uniform Delay (d), s/veh	9.9	8.6	8.6	14.5	7.2	6.6	24.0	0.0	23.1	25.9	0.0	22.2
Incr Delay (d2), s/veh	0.1	0.6	0.6	0.2	0.1	0.2	0.3	0.0	0.7	0.1	0.0	0.3
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	0.4	7.3	7.2	0.4	3.9	2.4	1.2	0.0	2.2	0.3	0.0	1.2
LnGrp Delay(d),s/veh	10.0	9.2	9.2	14.7	7.3	6.8	24.3	0.0	23.8	26.0	0.0	22.5
LnGrp LOS	B	A	A	B	A	A	C		C	C		C
Approach Vol, veh/h		1221			1079			197			91	
Approach Delay, s/veh		9.2			7.4			24.0			23.1	
Approach LOS		A			A			C			C	

Timer	1	2	3	4	5	6	7	8
Assigned Phs		2		4		6		8
Phs Duration (G+Y+Rc), s		48.7		21.9		48.7		21.9
Change Period (Y+Rc), s		6.0		6.0		6.0		6.0
Max Green Setting (Gmax), s		58.0		20.0		58.0		20.0
Max Q Clear Time (g_c+I1), s		21.0		7.5		17.7		8.2
Green Ext Time (p_c), s		21.7		1.1		22.7		1.0

Intersection Summary	
HCM 2010 Ctrl Delay	10.1
HCM 2010 LOS	B

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	66	834	204	49	637	256	97	7	125	18	9	40
Number	1	6	16	5	2	12	7	4	14	3	8	18
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1776	1776	1900	1827	1827	1827	1900	1810	1810	1845	1845	1900
Adj Flow Rate, veh/h	73	927	227	54	708	284	108	8	139	20	10	44
Adj No. of Lanes	1	2	0	1	2	1	0	1	1	1	1	0
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Percent Heavy Veh, %	7	7	7	4	4	4	5	5	5	3	3	3
Cap, veh/h	373	1623	397	290	2095	937	346	22	348	257	68	297
Arrive On Green	0.60	0.60	0.60	0.60	0.60	0.60	0.23	0.23	0.23	0.23	0.23	0.23
Sat Flow, veh/h	539	2689	658	476	3471	1553	1093	98	1538	1224	299	1314
Grp Volume(v), veh/h	73	581	573	54	708	284	116	0	139	20	0	54
Grp Sat Flow(s),veh/h/ln	539	1687	1660	476	1736	1553	1191	0	1538	1224	0	1613
Q Serve(g_s), s	5.5	14.7	14.7	5.5	7.2	6.3	5.2	0.0	5.4	1.0	0.0	1.9
Cycle Q Clear(g_c), s	12.7	14.7	14.7	20.2	7.2	6.3	7.1	0.0	5.4	8.1	0.0	1.9
Prop In Lane	1.00		0.40	1.00		1.00	0.93		1.00	1.00		0.81
Lane Grp Cap(c), veh/h	373	1018	1002	290	2095	937	368	0	348	257	0	365
V/C Ratio(X)	0.20	0.57	0.57	0.19	0.34	0.30	0.32	0.00	0.40	0.08	0.00	0.15
Avail Cap(c_a), veh/h	475	1338	1317	380	2754	1232	482	0	479	361	0	503
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.00	1.00	1.00	0.00	1.00
Uniform Delay (d), s/veh	10.1	8.5	8.5	14.6	7.0	6.8	24.5	0.0	23.2	27.4	0.0	21.9
Incr Delay (d2), s/veh	0.3	0.5	0.5	0.3	0.1	0.2	0.5	0.0	0.7	0.1	0.0	0.2
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	0.8	6.9	6.8	0.7	3.4	2.7	2.0	0.0	2.4	0.4	0.0	0.9
LnGrp Delay(d),s/veh	10.4	9.0	9.0	14.9	7.1	7.0	25.0	0.0	24.0	27.5	0.0	22.0
LnGrp LOS	B	A	A	B	A	A	C		C	C		C
Approach Vol, veh/h		1227			1046			255			74	
Approach Delay, s/veh		9.1			7.4			24.4			23.5	
Approach LOS		A			A			C			C	

Timer	1	2	3	4	5	6	7	8
Assigned Phs		2		4		6		8
Phs Duration (G+Y+Rc), s		48.6		22.0		48.6		22.0
Change Period (Y+Rc), s		6.0		6.0		6.0		6.0
Max Green Setting (Gmax), s		56.0		22.0		56.0		22.0
Max Q Clear Time (g_c+I1), s		22.2		9.1		16.7		10.1
Green Ext Time (p_c), s		20.4		1.3		22.2		1.2

Intersection Summary	
HCM 2010 Ctrl Delay	10.3
HCM 2010 LOS	B

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	25	27	211	99	8	13	503	1061	191	27	897	56
Number	3	8	18	7	4	14	1	6	16	5	2	12
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1810	1810	1810	1439	1439	1900	1810	1810	1900	1759	1759	1759
Adj Flow Rate, veh/h	28	30	234	110	9	14	559	1179	212	30	997	62
Adj No. of Lanes	1	1	1	1	1	0	2	3	0	1	3	1
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Percent Heavy Veh, %	5	5	5	32	32	32	5	5	5	8	8	8
Cap, veh/h	358	381	323	264	107	166	688	2096	377	93	1668	519
Arrive On Green	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.50	0.50	0.06	0.35	0.35
Sat Flow, veh/h	1343	1810	1538	858	509	791	3343	4212	757	1675	4803	1495
Grp Volume(v), veh/h	28	30	234	110	0	23	559	922	469	30	997	62
Grp Sat Flow(s),veh/h/ln	1343	1810	1538	858	0	1300	1672	1647	1676	1675	1601	1495
Q Serve(g_s), s	1.3	1.0	10.8	9.0	0.0	1.1	12.1	14.9	14.9	1.3	13.0	2.1
Cycle Q Clear(g_c), s	2.4	1.0	10.8	10.0	0.0	1.1	12.1	14.9	14.9	1.3	13.0	2.1
Prop In Lane	1.00		1.00	1.00		0.61	1.00		0.45	1.00		1.00
Lane Grp Cap(c), veh/h	358	381	323	264	0	273	688	1639	834	93	1668	519
V/C Ratio(X)	0.08	0.08	0.72	0.42	0.00	0.08	0.81	0.56	0.56	0.32	0.60	0.12
Avail Cap(c_a), veh/h	411	452	384	298	0	325	1055	1905	969	198	1831	570
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	1.00	1.00	0.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	25.1	24.1	28.0	28.1	0.0	24.2	28.8	13.3	13.3	34.5	20.4	16.9
Incr Delay (d2), s/veh	0.1	0.1	5.4	1.1	0.0	0.1	2.9	0.3	0.6	2.0	0.5	0.1
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	0.5	0.5	5.0	2.2	0.0	0.4	5.9	6.7	6.9	0.7	5.8	0.9
LnGrp Delay(d),s/veh	25.2	24.2	33.4	29.2	0.0	24.3	31.7	13.6	13.9	36.5	20.9	17.0
LnGrp LOS	C	C	C	C		C	C	B	B	D	C	B
Approach Vol, veh/h		292			133			1950			1089	
Approach Delay, s/veh		31.7			28.3			18.9			21.1	
Approach LOS		C			C			B			C	

Timer	1	2	3	4	5	6	7	8
Assigned Phs	1	2		4	5	6		8
Phs Duration (G+Y+Rc), s	21.7	32.4		22.0	10.2	43.9		22.0
Change Period (Y+Rc), s	6.0	6.0		6.0	6.0	6.0		6.0
Max Green Setting (Gmax), s	24.0	29.0		19.0	9.0	44.0		19.0
Max Q Clear Time (g_c+I1), s	14.1	15.0		12.0	3.3	16.9		12.8
Green Ext Time (p_c), s	1.5	11.4		1.1	0.0	19.3		1.0

Intersection Summary	
HCM 2010 Ctrl Delay	21.0
HCM 2010 LOS	C

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	71	11	413	218	26	16	238	1017	82	13	849	46
Number	3	8	18	7	4	14	1	6	16	5	2	12
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1863	1863	1863	1496	1496	1900	1827	1827	1900	1776	1776	1776
Adj Flow Rate, veh/h	79	12	459	242	29	18	264	1130	91	14	943	51
Adj No. of Lanes	1	1	1	1	1	0	2	3	0	1	3	1
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Percent Heavy Veh, %	2	2	2	27	27	27	4	4	4	7	7	7
Cap, veh/h	543	668	567	349	310	192	369	1846	149	51	1516	472
Arrive On Green	0.36	0.36	0.36	0.36	0.36	0.36	0.11	0.39	0.39	0.03	0.31	0.31
Sat Flow, veh/h	1353	1863	1583	738	865	537	3375	4706	379	1691	4848	1509
Grp Volume(v), veh/h	79	12	459	242	0	47	264	798	423	14	943	51
Grp Sat Flow(s),veh/h/ln	1353	1863	1583	738	0	1401	1688	1663	1760	1691	1616	1509
Q Serve(g_s), s	3.4	0.3	21.5	25.9	0.0	1.8	6.2	15.8	15.8	0.7	13.6	2.0
Cycle Q Clear(g_c), s	5.2	0.3	21.5	26.2	0.0	1.8	6.2	15.8	15.8	0.7	13.6	2.0
Prop In Lane	1.00		1.00	1.00		0.38	1.00		0.22	1.00		1.00
Lane Grp Cap(c), veh/h	543	668	567	349	0	502	369	1304	690	51	1516	472
V/C Ratio(X)	0.15	0.02	0.81	0.69	0.00	0.09	0.71	0.61	0.61	0.28	0.62	0.11
Avail Cap(c_a), veh/h	569	704	598	363	0	529	494	1304	690	185	1713	533
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	1.00	1.00	0.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	19.2	17.0	23.8	25.5	0.0	17.5	35.3	19.9	19.9	38.9	24.1	20.1
Incr Delay (d2), s/veh	0.1	0.0	7.8	5.3	0.0	0.1	3.2	0.8	1.6	2.9	0.6	0.1
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	1.3	0.2	10.6	5.8	0.0	0.7	3.1	7.4	7.9	0.4	6.1	0.8
LnGrp Delay(d),s/veh	19.3	17.0	31.6	30.8	0.0	17.6	38.5	20.8	21.5	41.8	24.6	20.2
LnGrp LOS	B	B	C	C		B	D	C	C	D	C	C
Approach Vol, veh/h		550			289			1485			1008	
Approach Delay, s/veh		29.5			28.6			24.2			24.6	
Approach LOS		C			C			C			C	

Timer	1	2	3	4	5	6	7	8
Assigned Phs	1	2		4	5	6		8
Phs Duration (G+Y+Rc), s	15.0	31.7		35.4	8.5	38.2		35.4
Change Period (Y+Rc), s	6.0	6.0		6.0	6.0	6.0		6.0
Max Green Setting (Gmax), s	12.0	29.0		31.0	9.0	32.0		31.0
Max Q Clear Time (g_c+I1), s	8.2	15.6		28.2	2.7	17.8		23.5
Green Ext Time (p_c), s	0.3	10.1		1.2	0.0	10.8		2.6

Intersection Summary	
HCM 2010 Ctrl Delay	25.6
HCM 2010 LOS	C

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	0	0	0	468	0	304	231	1451	0	0	1053	154
Number				3	8	18	5	2	12	1	6	16
Initial Q (Qb), veh				0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)				1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj				1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln				1727	0	1727	1776	1776	0	0	1810	1810
Adj Flow Rate, veh/h				520	0	338	257	1612	0	0	1170	171
Adj No. of Lanes				2	0	1	2	3	0	0	3	1
Peak Hour Factor				0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Percent Heavy Veh, %				10	0	10	7	7	0	0	5	5
Cap, veh/h				867	0	399	374	2792	0	0	1906	593
Arrive On Green				0.27	0.00	0.27	0.11	0.58	0.00	0.00	0.39	0.39
Sat Flow, veh/h				3191	0	1468	3281	5007	0	0	5103	1538
Grp Volume(v), veh/h				520	0	338	257	1612	0	0	1170	171
Grp Sat Flow(s),veh/h/ln				1596	0	1468	1640	1616	0	0	1647	1538
Q Serve(g_s), s				11.2	0.0	17.1	5.9	16.6	0.0	0.0	15.0	6.0
Cycle Q Clear(g_c), s				11.2	0.0	17.1	5.9	16.6	0.0	0.0	15.0	6.0
Prop In Lane				1.00		1.00	1.00		0.00	0.00		1.00
Lane Grp Cap(c), veh/h				867	0	399	374	2792	0	0	1906	593
V/C Ratio(X)				0.60	0.00	0.85	0.69	0.58	0.00	0.00	0.61	0.29
Avail Cap(c_a), veh/h				1135	0	522	500	3079	0	0	2008	625
HCM Platoon Ratio				1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)				1.00	0.00	1.00	1.00	1.00	0.00	0.00	1.00	1.00
Uniform Delay (d), s/veh				24.9	0.0	27.1	33.5	10.6	0.0	0.0	19.5	16.7
Incr Delay (d2), s/veh				0.7	0.0	9.8	2.5	0.2	0.0	0.0	0.5	0.3
Initial Q Delay(d3),s/veh				0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln				5.0	0.0	8.0	2.8	7.4	0.0	0.0	6.9	2.6
LnGrp Delay(d),s/veh				25.6	0.0	36.9	36.0	10.8	0.0	0.0	20.0	17.0
LnGrp LOS				C		D	D	B			B	B
Approach Vol, veh/h					858			1869			1341	
Approach Delay, s/veh					30.1			14.3			19.6	
Approach LOS					C			B			B	

Timer	1	2	3	4	5	6	7	8
Assigned Phs		2			5	6		8
Phs Duration (G+Y+Rc), s		51.3			15.0	36.4		27.4
Change Period (Y+Rc), s		6.0			6.0	6.0		6.0
Max Green Setting (Gmax), s		50.0			12.0	32.0		28.0
Max Q Clear Time (g_c+I1), s		18.6			7.9	17.0		19.1
Green Ext Time (p_c), s		25.4			0.3	13.4		2.2

Intersection Summary	
HCM 2010 Ctrl Delay	19.4
HCM 2010 LOS	B

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	0	0	0	622	0	240	540	1097	0	0	1239	241
Number				3	8	18	5	2	12	1	6	16
Initial Q (Qb), veh				0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)				1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj				1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln				1759	0	1759	1810	1810	0	0	1827	1827
Adj Flow Rate, veh/h				691	0	267	600	1219	0	0	1377	268
Adj No. of Lanes				2	0	1	2	3	0	0	3	1
Peak Hour Factor				0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Percent Heavy Veh, %				8	0	8	5	5	0	0	4	4
Cap, veh/h				790	0	364	681	3049	0	0	1714	534
Arrive On Green				0.24	0.00	0.24	0.20	0.62	0.00	0.00	0.34	0.34
Sat Flow, veh/h				3250	0	1495	3343	5103	0	0	5152	1553
Grp Volume(v), veh/h				691	0	267	600	1219	0	0	1377	268
Grp Sat Flow(s),veh/h/ln				1625	0	1495	1672	1647	0	0	1663	1553
Q Serve(g_s), s				17.6	0.0	14.1	15.0	10.8	0.0	0.0	21.5	11.8
Cycle Q Clear(g_c), s				17.6	0.0	14.1	15.0	10.8	0.0	0.0	21.5	11.8
Prop In Lane				1.00		1.00	1.00		0.00	0.00		1.00
Lane Grp Cap(c), veh/h				790	0	364	681	3049	0	0	1714	534
V/C Ratio(X)				0.87	0.00	0.73	0.88	0.40	0.00	0.00	0.80	0.50
Avail Cap(c_a), veh/h				870	0	400	739	3163	0	0	1742	542
HCM Platoon Ratio				1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)				1.00	0.00	1.00	1.00	1.00	0.00	0.00	1.00	1.00
Uniform Delay (d), s/veh				31.2	0.0	30.0	33.2	8.4	0.0	0.0	25.6	22.4
Incr Delay (d2), s/veh				9.2	0.0	6.2	11.4	0.1	0.0	0.0	2.8	0.7
Initial Q Delay(d3),s/veh				0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln				8.9	0.0	6.5	8.0	4.9	0.0	0.0	10.3	5.1
LnGrp Delay(d),s/veh				40.5	0.0	36.2	44.6	8.4	0.0	0.0	28.4	23.1
LnGrp LOS				D		D	D	A			C	C
Approach Vol, veh/h					958			1819			1645	
Approach Delay, s/veh					39.3			20.4			27.5	
Approach LOS					D			C			C	

Timer	1	2	3	4	5	6	7	8
Assigned Phs		2			5	6		8
Phs Duration (G+Y+Rc), s		59.0			23.5	35.5		26.9
Change Period (Y+Rc), s		6.0			6.0	6.0		6.0
Max Green Setting (Gmax), s		55.0			19.0	30.0		23.0
Max Q Clear Time (g_c+I1), s		12.8			17.0	23.5		19.6
Green Ext Time (p_c), s		30.5			0.5	6.0		1.3

Intersection Summary	
HCM 2010 Ctrl Delay	27.1
HCM 2010 LOS	C

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	8	78	321	104	38	11	241	327	204	4	176	25
Number	7	4	14	3	8	18	5	2	12	1	6	16
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1900	1827	1827	1845	1845	1900	1792	1792	1792	1900	1810	1900
Adj Flow Rate, veh/h	9	87	357	116	42	12	268	363	227	4	196	28
Adj No. of Lanes	0	1	1	1	1	0	1	1	1	0	2	0
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Percent Heavy Veh, %	4	4	4	3	3	3	6	6	6	5	5	5
Cap, veh/h	64	396	586	452	568	162	513	778	661	51	607	85
Arrive On Green	0.23	0.23	0.23	0.11	0.41	0.41	0.15	0.43	0.43	0.21	0.21	0.21
Sat Flow, veh/h	60	1744	1553	1757	1381	394	1707	1792	1524	15	2939	410
Grp Volume(v), veh/h	96	0	357	116	0	54	268	363	227	120	0	108
Grp Sat Flow(s),veh/h/ln	1804	0	1553	1757	0	1775	1707	1792	1524	1790	0	1574
Q Serve(g_s), s	0.0	0.0	14.4	3.5	0.0	1.4	8.9	11.1	7.7	0.0	0.0	4.5
Cycle Q Clear(g_c), s	3.3	0.0	14.4	3.5	0.0	1.4	8.9	11.1	7.7	4.4	0.0	4.5
Prop In Lane	0.09		1.00	1.00		0.22	1.00		1.00	0.03		0.26
Lane Grp Cap(c), veh/h	461	0	586	452	0	730	513	778	661	418	0	325
V/C Ratio(X)	0.21	0.00	0.61	0.26	0.00	0.07	0.52	0.47	0.34	0.29	0.00	0.33
Avail Cap(c_a), veh/h	583	0	694	582	0	985	1006	1503	1278	619	0	508
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	0.00	1.00	1.00	0.00	1.00	1.00	1.00	1.00	1.00	0.00	1.00
Uniform Delay (d), s/veh	24.4	0.0	19.5	17.2	0.0	13.9	17.9	15.6	14.6	26.1	0.0	26.2
Incr Delay (d2), s/veh	0.2	0.0	1.1	0.3	0.0	0.0	0.8	0.4	0.3	0.4	0.0	0.6
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	1.7	0.0	6.4	1.7	0.0	0.7	4.2	5.5	3.3	2.2	0.0	2.0
LnGrp Delay(d),s/veh	24.6	0.0	20.6	17.5	0.0	13.9	18.7	16.0	14.9	26.5	0.0	26.8
LnGrp LOS	C		C	B		B	B	B	B	C		C
Approach Vol, veh/h		453			170			858			228	
Approach Delay, s/veh		21.5			16.4			16.6			26.6	
Approach LOS		C			B			B			C	

Timer	1	2	3	4	5	6	7	8
Assigned Phs		2	3	4	5	6		8
Phs Duration (G+Y+Rc), s		39.6	14.3	23.6	17.6	22.0		37.9
Change Period (Y+Rc), s		6.0	6.0	6.0	6.0	6.0		6.0
Max Green Setting (Gmax), s		65.0	14.0	23.0	34.0	25.0		43.0
Max Q Clear Time (g_c+I1), s		13.1	5.5	16.4	10.9	6.5		3.4
Green Ext Time (p_c), s		4.8	0.2	1.2	0.8	4.1		2.2

Intersection Summary	
HCM 2010 Ctrl Delay	19.2
HCM 2010 LOS	B

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	13	46	391	175	69	6	259	246	158	4	320	24
Number	7	4	14	3	8	18	5	2	12	1	6	16
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1900	1845	1845	1863	1863	1900	1810	1810	1810	1900	1827	1900
Adj Flow Rate, veh/h	14	51	434	194	77	7	288	273	176	4	356	27
Adj No. of Lanes	0	1	1	1	1	0	1	1	1	0	2	0
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Percent Heavy Veh, %	3	3	3	2	2	2	5	5	5	4	4	4
Cap, veh/h	108	343	604	469	696	63	460	788	670	48	642	48
Arrive On Green	0.23	0.23	0.23	0.11	0.41	0.41	0.16	0.44	0.44	0.20	0.20	0.20
Sat Flow, veh/h	233	1512	1568	1774	1683	153	1723	1810	1538	9	3189	239
Grp Volume(v), veh/h	65	0	434	194	0	84	288	273	176	204	0	183
Grp Sat Flow(s),veh/h/ln	1746	0	1568	1774	0	1836	1723	1810	1538	1818	0	1620
Q Serve(g_s), s	0.0	0.0	18.0	6.2	0.0	2.2	9.8	8.0	5.8	0.0	0.0	8.1
Cycle Q Clear(g_c), s	2.2	0.0	18.0	6.2	0.0	2.2	9.8	8.0	5.8	8.0	0.0	8.1
Prop In Lane	0.22		1.00	1.00		0.08	1.00		1.00	0.02		0.15
Lane Grp Cap(c), veh/h	450	0	604	469	0	759	460	788	670	412	0	326
V/C Ratio(X)	0.14	0.00	0.72	0.41	0.00	0.11	0.63	0.35	0.26	0.50	0.00	0.56
Avail Cap(c_a), veh/h	450	0	604	650	0	947	903	1526	1297	683	0	571
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	0.00	1.00	1.00	0.00	1.00	1.00	1.00	1.00	1.00	0.00	1.00
Uniform Delay (d), s/veh	24.6	0.0	20.8	18.2	0.0	14.3	19.0	14.9	14.3	28.5	0.0	28.6
Incr Delay (d2), s/veh	0.1	0.0	4.1	0.6	0.0	0.1	1.4	0.3	0.2	0.9	0.0	1.5
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	1.2	0.0	8.8	3.0	0.0	1.1	4.7	4.0	2.5	4.1	0.0	3.7
LnGrp Delay(d),s/veh	24.8	0.0	24.9	18.8	0.0	14.4	20.4	15.2	14.5	29.5	0.0	30.1
LnGrp LOS	C		C	B		B	C	B	B	C		C
Approach Vol, veh/h		499			278			737			387	
Approach Delay, s/veh		24.9			17.5			17.0			29.7	
Approach LOS		C			B			B			C	

Timer	1	2	3	4	5	6	7	8
Assigned Phs		2	3	4	5	6		8
Phs Duration (G+Y+Rc), s		40.6	14.9	24.0	18.6	22.0		38.9
Change Period (Y+Rc), s		6.0	6.0	6.0	6.0	6.0		6.0
Max Green Setting (Gmax), s		67.0	17.0	18.0	33.0	28.0		41.0
Max Q Clear Time (g_c+I1), s		10.0	8.2	20.0	11.8	10.1		4.2
Green Ext Time (p_c), s		5.0	0.3	0.0	0.8	4.2		2.5

Intersection Summary	
HCM 2010 Ctrl Delay	21.8
HCM 2010 LOS	C

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	123	853	0	0	450	109	299	0	56	0	0	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	6.0	6.0			6.0		6.0		6.0			
Lane Util. Factor	1.00	0.95			0.95		0.97		1.00			
Frt	1.00	1.00			0.97		1.00		0.85			
Flt Protected	0.95	1.00			1.00		0.95		1.00			
Satd. Flow (prot)	1671	3343			3306		2943		1357			
Flt Permitted	0.34	1.00			1.00		0.95		1.00			
Satd. Flow (perm)	600	3343			3306		2943		1357			
Peak-hour factor, PHF	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Adj. Flow (vph)	137	948	0	0	500	121	332	0	62	0	0	0
RTOR Reduction (vph)	0	0	0	0	18	0	0	0	49	0	0	0
Lane Group Flow (vph)	137	948	0	0	603	0	332	0	13	0	0	0
Heavy Vehicles (%)	8%	8%	8%	6%	6%	6%	19%	19%	19%	2%	2%	2%
Turn Type	custom	NA			NA		Prot		Prot			
Protected Phases	5 8	2 5 8			6		7		7			
Permitted Phases	2						7		7			
Actuated Green, G (s)	71.3	71.3			43.2		24.3		24.3			
Effective Green, g (s)	71.3	71.3			43.2		24.3		24.3			
Actuated g/C Ratio	0.61	0.61			0.37		0.21		0.21			
Clearance Time (s)					6.0		6.0		6.0			
Vehicle Extension (s)					3.0		3.0		3.0			
Lane Grp Cap (vph)	652	2044			1224		613		282			
v/s Ratio Prot	0.06	c0.28			c0.18		c0.11		0.01			
v/s Ratio Perm	0.07											
v/c Ratio	0.21	0.46			0.49		0.54		0.05			
Uniform Delay, d1	9.9	12.3			28.3		41.2		36.9			
Progression Factor	0.83	0.86			1.00		1.00		1.00			
Incremental Delay, d2	0.1	0.1			0.3		1.0		0.1			
Delay (s)	8.3	10.6			28.6		42.2		37.0			
Level of Service	A	B			C		D		D			
Approach Delay (s)		10.3			28.6			41.3			0.0	
Approach LOS		B			C			D			A	

Intersection Summary			
HCM 2000 Control Delay	21.6	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.53		
Actuated Cycle Length (s)	116.6	Sum of lost time (s)	24.0
Intersection Capacity Utilization	76.9%	ICU Level of Service	D
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	244	624	0	0	682	276	327	0	102	0	0	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	6.0	6.0			6.0		6.0		6.0			
Lane Util. Factor	1.00	0.95			0.95		0.97		1.00			
Frt	1.00	1.00			0.96		1.00		0.85			
Flt Protected	0.95	1.00			1.00		0.95		1.00			
Satd. Flow (prot)	1703	3406			3289		3072		1417			
Flt Permitted	0.14	1.00			1.00		0.95		1.00			
Satd. Flow (perm)	251	3406			3289		3072		1417			
Peak-hour factor, PHF	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Adj. Flow (vph)	271	693	0	0	758	307	363	0	113	0	0	0
RTOR Reduction (vph)	0	0	0	0	36	0	0	0	95	0	0	0
Lane Group Flow (vph)	271	693	0	0	1029	0	363	0	18	0	0	0
Heavy Vehicles (%)	6%	6%	6%	5%	5%	5%	14%	14%	14%	2%	2%	2%
Turn Type	custom	NA			NA		Prot		Prot			
Protected Phases	5 8	2 5 8			6		7		7			
Permitted Phases	2						7		7			
Actuated Green, G (s)	72.8	72.8			46.2		18.4		18.4			
Effective Green, g (s)	72.8	72.8			46.2		18.4		18.4			
Actuated g/C Ratio	0.63	0.63			0.40		0.16		0.16			
Clearance Time (s)					6.0		6.0		6.0			
Vehicle Extension (s)					3.0		3.0		3.0			
Lane Grp Cap (vph)	567	2158			1322		491		226			
v/s Ratio Prot	c0.13	0.20			c0.31		c0.12		0.01			
v/s Ratio Perm	0.17											
v/c Ratio	0.48	0.32			0.78		0.74		0.08			
Uniform Delay, d1	14.2	9.7			29.9		46.0		41.0			
Progression Factor	2.68	0.79			1.00		1.00		1.00			
Incremental Delay, d2	0.5	0.1			3.0		5.8		0.2			
Delay (s)	38.4	7.7			32.9		51.7		41.2			
Level of Service	D	A			C		D		D			
Approach Delay (s)		16.3			32.9			49.2			0.0	
Approach LOS		B			C			D			A	

Intersection Summary			
HCM 2000 Control Delay	29.6	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.71		
Actuated Cycle Length (s)	114.9	Sum of lost time (s)	24.0
Intersection Capacity Utilization	65.5%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	644	582	69	680	0	0	0	0	332	0	224
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		6.0	6.0	6.0	6.0					6.0		6.0
Lane Util. Factor		0.95	1.00	1.00	0.95					1.00		1.00
Frt		1.00	0.85	1.00	1.00					1.00		0.85
Flt Protected		1.00	1.00	0.95	1.00					0.95		1.00
Satd. Flow (prot)		3282	1468	1671	3343					1612		1442
Flt Permitted		1.00	1.00	0.23	1.00					0.95		1.00
Satd. Flow (perm)		3282	1468	401	3343					1612		1442
Peak-hour factor, PHF	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Adj. Flow (vph)	0	716	647	77	756	0	0	0	0	369	0	249
RTOR Reduction (vph)	0	0	133	0	0	0	0	0	0	0	0	80
Lane Group Flow (vph)	0	716	514	77	756	0	0	0	0	369	0	169
Heavy Vehicles (%)	10%	10%	10%	8%	8%	8%	2%	2%	2%	12%	12%	12%
Turn Type		NA	custom	custom	NA					custom		custom
Protected Phases		2		1	1 6					7 8		7 8
Permitted Phases			2 7 8	6						7 8		7 8
Actuated Green, G (s)		40.2	92.6	55.2	55.2					46.4		46.4
Effective Green, g (s)		40.2	92.6	55.2	55.2					46.4		46.4
Actuated g/C Ratio		0.34	0.79	0.47	0.47					0.40		0.40
Clearance Time (s)		6.0		6.0								
Vehicle Extension (s)		3.0		3.0								
Lane Grp Cap (vph)		1131	1165	320	1582					641		573
v/s Ratio Prot		c0.22		0.02	c0.23					c0.23		0.12
v/s Ratio Perm			0.35	0.09								
v/c Ratio		0.63	0.44	0.24	0.48					0.58		0.29
Uniform Delay, d1		32.0	3.8	18.4	20.9					27.4		23.9
Progression Factor		1.00	1.00	0.39	1.12					1.00		1.00
Incremental Delay, d2		1.2	0.3	0.3	0.2					1.3		0.3
Delay (s)		33.2	4.1	7.6	23.5					28.7		24.2
Level of Service		C	A	A	C					C		C
Approach Delay (s)		19.4			22.0			0.0			26.9	
Approach LOS		B			C			A			C	

Intersection Summary			
HCM 2000 Control Delay	21.8	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.63		
Actuated Cycle Length (s)	116.6	Sum of lost time (s)	24.0
Intersection Capacity Utilization	76.9%	ICU Level of Service	D
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	694	408	100	909	0	0	0	0	174	0	205
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		6.0	6.0	6.0	6.0					6.0		6.0
Lane Util. Factor		0.95	1.00	1.00	0.95					1.00		1.00
Frt		1.00	0.85	1.00	1.00					1.00		0.85
Flt Protected		1.00	1.00	0.95	1.00					0.95		1.00
Satd. Flow (prot)		3343	1495	1703	3406					1570		1404
Flt Permitted		1.00	1.00	0.19	1.00					0.95		1.00
Satd. Flow (perm)		3343	1495	347	3406					1570		1404
Peak-hour factor, PHF	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Adj. Flow (vph)	0	771	453	111	1010	0	0	0	0	193	0	228
RTOR Reduction (vph)	0	0	111	0	0	0	0	0	0	0	0	57
Lane Group Flow (vph)	0	771	342	111	1010	0	0	0	0	193	0	171
Heavy Vehicles (%)	8%	8%	8%	6%	6%	6%	2%	2%	2%	15%	15%	15%
Turn Type		NA	custom	custom	NA					custom		custom
Protected Phases		2		1	1 6					7 8		7 8
Permitted Phases			2 7 8	6						7 8		7 8
Actuated Green, G (s)		40.5	86.8	62.3	62.3					40.3		40.3
Effective Green, g (s)		40.5	86.8	62.3	62.3					40.3		40.3
Actuated g/C Ratio		0.35	0.76	0.54	0.54					0.35		0.35
Clearance Time (s)		6.0		6.0								
Vehicle Extension (s)		3.0		3.0								
Lane Grp Cap (vph)		1178	1129	378	1846					550		492
v/s Ratio Prot		c0.23		0.04	c0.30					c0.12		0.12
v/s Ratio Perm			0.23	0.12								
v/c Ratio		0.65	0.30	0.29	0.55					0.35		0.35
Uniform Delay, d1		31.3	4.5	15.3	17.1					27.6		27.6
Progression Factor		1.00	1.00	0.93	0.99					1.00		1.00
Incremental Delay, d2		1.3	0.2	0.3	0.2					0.4		0.4
Delay (s)		32.6	4.6	14.5	17.2					28.0		28.0
Level of Service		C	A	B	B					C		C
Approach Delay (s)		22.3			17.0			0.0			28.0	
Approach LOS		C			B			A			C	

Intersection Summary			
HCM 2000 Control Delay	21.0	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.56		
Actuated Cycle Length (s)	114.9	Sum of lost time (s)	24.0
Intersection Capacity Utilization	65.5%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	148	214	266	178	108	58	453	1167	279	36	566	82
Number	3	8	18	7	4	14	1	6	16	5	2	12
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1792	1792	1792	1776	1776	1900	1810	1810	1810	1810	1810	1810
Adj Flow Rate, veh/h	164	238	296	198	120	64	503	1297	310	40	629	91
Adj No. of Lanes	1	2	1	1	2	0	1	2	1	1	2	1
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Percent Heavy Veh, %	6	6	6	7	7	7	5	5	5	5	5	5
Cap, veh/h	279	623	626	314	708	356	541	1927	862	153	947	424
Arrive On Green	0.18	0.18	0.18	0.09	0.33	0.33	0.23	0.56	0.56	0.28	0.28	0.28
Sat Flow, veh/h	1150	3406	1524	1691	2174	1095	1723	3438	1538	305	3438	1538
Grp Volume(v), veh/h	164	238	296	198	92	92	503	1297	310	40	629	91
Grp Sat Flow(s),veh/h/ln	1150	1703	1524	1691	1687	1582	1723	1719	1538	305	1719	1538
Q Serve(g_s), s	14.3	6.5	14.9	9.0	4.1	4.4	20.7	28.0	11.7	11.5	17.1	4.8
Cycle Q Clear(g_c), s	14.3	6.5	14.9	9.0	4.1	4.4	20.7	28.0	11.7	11.5	17.1	4.8
Prop In Lane	1.00		1.00	1.00		0.69	1.00		1.00	1.00		1.00
Lane Grp Cap(c), veh/h	279	623	626	314	549	515	541	1927	862	153	947	424
V/C Ratio(X)	0.59	0.38	0.47	0.63	0.17	0.18	0.93	0.67	0.36	0.26	0.66	0.21
Avail Cap(c_a), veh/h	320	745	680	314	609	572	689	2288	1024	158	1013	453
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	41.0	37.8	22.7	31.5	25.3	25.4	20.6	16.3	12.7	31.8	33.8	29.3
Incr Delay (d2), s/veh	2.2	0.4	0.6	4.1	0.1	0.2	16.5	0.6	0.3	0.9	1.5	0.3
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	4.7	3.1	6.3	1.5	1.9	2.0	12.1	13.3	5.0	1.0	8.3	2.1
LnGrp Delay(d),s/veh	43.1	38.1	23.2	35.5	25.4	25.6	37.1	16.9	13.0	32.7	35.3	29.6
LnGrp LOS	D	D	C	D	C	C	D	B	B	C	D	C
Approach Vol, veh/h		698			382			2110			760	
Approach Delay, s/veh		33.0			30.7			21.1			34.5	
Approach LOS		C			C			C			C	

Timer	1	2	3	4	5	6	7	8
Assigned Phs	1	2		4		6	7	8
Phs Duration (G+Y+Rc), s	30.0	35.0		40.2		64.9	15.0	25.2
Change Period (Y+Rc), s	6.0	6.0		6.0		6.0	6.0	6.0
Max Green Setting (Gmax), s	33.0	31.0		38.0		70.0	9.0	23.0
Max Q Clear Time (g_c+I1), s	22.7	19.1		6.4		30.0	11.0	16.9
Green Ext Time (p_c), s	1.3	9.9		4.6		24.8	0.0	2.3

Intersection Summary	
HCM 2010 Ctrl Delay	26.7
HCM 2010 LOS	C

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	77	121	495	253	277	54	304	743	161	27	1042	102
Number	3	8	18	7	4	14	1	6	16	5	2	12
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1810	1810	1810	1810	1810	1900	1827	1827	1827	1827	1827	1827
Adj Flow Rate, veh/h	86	134	550	281	308	60	338	826	179	30	1158	113
Adj No. of Lanes	1	2	1	1	2	0	1	2	1	1	2	1
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Percent Heavy Veh, %	5	5	5	5	5	5	4	4	4	4	4	4
Cap, veh/h	202	484	458	323	861	166	369	2066	924	275	1338	599
Arrive On Green	0.14	0.14	0.14	0.11	0.30	0.30	0.16	0.60	0.60	0.39	0.39	0.39
Sat Flow, veh/h	981	3438	1538	1723	2877	554	1740	3471	1553	548	3471	1553
Grp Volume(v), veh/h	86	134	550	281	182	186	338	826	179	30	1158	113
Grp Sat Flow(s),veh/h/ln	981	1719	1538	1723	1719	1712	1740	1736	1553	548	1736	1553
Q Serve(g_s), s	9.4	4.0	16.0	12.0	9.5	9.7	15.3	14.4	6.0	4.0	34.9	5.5
Cycle Q Clear(g_c), s	9.4	4.0	16.0	12.0	9.5	9.7	15.3	14.4	6.0	4.0	34.9	5.5
Prop In Lane	1.00		1.00	1.00		0.32	1.00		1.00	1.00		1.00
Lane Grp Cap(c), veh/h	202	484	458	323	514	512	369	2066	924	275	1338	599
V/C Ratio(X)	0.43	0.28	1.20	0.87	0.35	0.36	0.92	0.40	0.19	0.11	0.87	0.19
Avail Cap(c_a), veh/h	202	484	458	323	514	512	449	2261	1011	280	1375	615
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	46.0	43.6	39.9	39.6	31.2	31.3	29.9	12.2	10.5	22.7	32.2	23.1
Incr Delay (d2), s/veh	1.4	0.3	110.1	21.6	0.4	0.4	20.9	0.1	0.1	0.2	5.9	0.2
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	2.6	1.9	28.3	5.1	4.6	4.6	12.5	6.9	2.6	0.6	17.8	2.4
LnGrp Delay(d),s/veh	47.4	43.9	150.0	61.2	31.6	31.7	50.8	12.3	10.6	22.9	38.1	23.3
LnGrp LOS	D	D	F	E	C	C	D	B	B	C	D	C
Approach Vol, veh/h		770			649			1343			1301	
Approach Delay, s/veh		120.1			44.5			21.8			36.5	
Approach LOS		F			D			C			D	

Timer	1	2	3	4	5	6	7	8
Assigned Phs	1	2		4		6	7	8
Phs Duration (G+Y+Rc), s	23.8	49.8		40.0		73.6	18.0	22.0
Change Period (Y+Rc), s	6.0	6.0		6.0		6.0	6.0	6.0
Max Green Setting (Gmax), s	23.0	45.0		34.0		74.0	12.0	16.0
Max Q Clear Time (g_c+I1), s	17.3	36.9		11.7		16.4	14.0	18.0
Green Ext Time (p_c), s	0.5	6.9		5.8		28.5	0.0	0.0

Intersection Summary	
HCM 2010 Ctrl Delay	48.7
HCM 2010 LOS	D

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (veh/h)	5	210	196	218	568	4
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90
Hourly flow rate (vph)	6	233	218	242	631	4
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type		None	None			
Median storage veh)						
Upstream signal (ft)			1199			
pX, platoon unblocked						
vC, conflicting volume	460				467	230
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	460				467	230
tC, single (s)	4.2				7.0	7.1
tC, 2 stage (s)						
tF (s)	2.3				3.6	3.4
p0 queue free %	99				0	99
cM capacity (veh/h)	1063				505	751

Direction, Lane #	EB 1	EB 2	EB 3	WB 1	WB 2	SB 1	SB 2
Volume Total	6	117	117	145	315	421	215
Volume Left	6	0	0	0	0	421	210
Volume Right	0	0	0	0	242	0	4
cSH	1063	1700	1700	1700	1700	505	508
Volume to Capacity	0.01	0.07	0.07	0.09	0.19	0.83	0.42
Queue Length 95th (ft)	0	0	0	0	0	209	52
Control Delay (s)	8.4	0.0	0.0	0.0	0.0	38.5	17.2
Lane LOS	A					E	C
Approach Delay (s)	0.2			0.0		31.3	
Approach LOS						D	

Intersection Summary			
Average Delay	14.9		
Intersection Capacity Utilization	35.4%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (veh/h)	6	198	509	186	221	7
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90
Hourly flow rate (vph)	7	220	566	207	246	8
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type		None	None			
Median storage veh)						
Upstream signal (ft)			1199			
pX, platoon unblocked	0.93				0.93	0.93
vC, conflicting volume	772				792	386
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	615				637	202
tC, single (s)	4.1				7.0	7.1
tC, 2 stage (s)						
tF (s)	2.2				3.6	3.4
p0 queue free %	99				33	99
cM capacity (veh/h)	897				366	732

Direction, Lane #	EB 1	EB 2	EB 3	WB 1	WB 2	SB 1	SB 2
Volume Total	7	110	110	377	395	164	90
Volume Left	7	0	0	0	0	164	82
Volume Right	0	0	0	0	207	0	8
cSH	897	1700	1700	1700	1700	366	382
Volume to Capacity	0.01	0.06	0.06	0.22	0.23	0.45	0.23
Queue Length 95th (ft)	1	0	0	0	0	56	22
Control Delay (s)	9.0	0.0	0.0	0.0	0.0	22.6	17.3
Lane LOS	A					C	C
Approach Delay (s)	0.3			0.0		20.7	
Approach LOS						C	

Intersection Summary			
Average Delay	4.2		
Intersection Capacity Utilization	33.2%	ICU Level of Service	A
Analysis Period (min)	15		

Intersection	
Int Delay, s/veh	7.8

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR
Vol, veh/h	0	0	200	0	0	223	0	88	572
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0
Sign Control	Stop	Stop	Stop	Stop	Stop	Stop	Free	Free	Free
RT Channelized	-	-	Yield	-	-	Yield	-	-	Free
Storage Length	-	-	0	-	-	0	125	-	0
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-
Peak Hour Factor	90	90	90	90	90	90	90	90	90
Heavy Vehicles, %	7	7	7	9	9	9	4	4	4
Mvmt Flow	0	0	222	0	0	248	0	98	636

Major/Minor	Minor2			Minor1			Major1		
Conflicting Flow All	62	111	13	111	111	49	13	0	-
Stage 1	13	13	-	98	98	-	-	-	-
Stage 2	49	98	-	13	13	-	-	-	-
Critical Hdwy	7.405	6.605	6.305	7.435	6.635	7.035	4.14	-	-
Critical Hdwy Stg 1	6.205	5.605	-	6.635	5.635	-	-	-	-
Critical Hdwy Stg 2	6.605	5.605	-	6.235	5.635	-	-	-	-
Follow-up Hdwy	3.5665	4.0665	3.3665	3.5855	4.0855	3.3855	2.236	-	-
Pot Cap-1 Maneuver	916	768	1052	843	764	989	1593	-	0
Stage 1	993	874	-	880	799	-	-	-	0
Stage 2	945	803	-	988	870	-	-	-	0
Platoon blocked, %								-	
Mov Cap-1 Maneuver	687	768	1052	665	764	989	1593	-	-
Mov Cap-2 Maneuver	687	768	-	665	764	-	-	-	-
Stage 1	993	874	-	880	799	-	-	-	-
Stage 2	708	803	-	779	870	-	-	-	-

Approach	EB	WB	NB
HCM Control Delay, s	9.3	9.9	
HCM LOS	A	A	

Minor Lane/Major Mvmt	NBL	NBT	EBLn1	WBLn1	SBL	SBT
Capacity (veh/h)	1593	-	1052	989	1478	-
HCM Lane V/C Ratio	-	-	0.211	0.251	-	-
HCM Control Delay (s)	0	-	9.3	9.9	0	-
HCM Lane LOS	A	-	A	A	A	-
HCM 95th %tile Q(veh)	0	-	1	1	0	-

Intersection			
Int Delay, s/veh			

Movement	SBL	SBT	SBR
Vol, veh/h	0	12	215
Conflicting Peds, #/hr	0	0	0
Sign Control	Free	Free	Free
RT Channelized	-	-	Free
Storage Length	-	-	-
Veh in Median Storage, #	-	0	-
Grade, %	-	0	-
Peak Hour Factor	90	90	90
Heavy Vehicles, %	4	4	4
Mvmt Flow	0	13	239

Major/Minor	Major2		
Conflicting Flow All	98	0	0
Stage 1	-	-	-
Stage 2	-	-	-
Critical Hdwy	4.18	-	-
Critical Hdwy Stg 1	-	-	-
Critical Hdwy Stg 2	-	-	-
Follow-up Hdwy	2.24	-	-
Pot Cap-1 Maneuver	1478	-	0
Stage 1	-	-	0
Stage 2	-	-	0
Platoon blocked, %		-	
Mov Cap-1 Maneuver	1478	-	-
Mov Cap-2 Maneuver	-	-	-
Stage 1	-	-	-
Stage 2	-	-	-

Approach	SB
HCM Control Delay, s	
HCM LOS	

Minor Lane/Major Mvmt

Intersection	
Int Delay, s/veh	11.5

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR
Vol, veh/h	0	0	516	0	0	192	0	13	228
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0
Sign Control	Stop	Stop	Stop	Stop	Stop	Stop	Free	Free	Free
RT Channelized	-	-	Yield	-	-	Yield	-	-	Free
Storage Length	-	-	0	-	-	0	125	-	0
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-
Peak Hour Factor	90	90	90	90	90	90	90	90	90
Heavy Vehicles, %	2	2	2	9	9	9	3	3	3
Mvmt Flow	0	0	573	0	0	213	0	14	253

Major/Minor	Minor2			Minor1			Major1		
Conflicting Flow All	139	146	132	146	146	7	132	0	-
Stage 1	132	132	-	14	14	-	-	-	-
Stage 2	7	14	-	132	132	-	-	-	-
Critical Hdwy	7.33	6.53	6.23	7.435	6.635	7.035	4.13	-	-
Critical Hdwy Stg 1	6.13	5.53	-	6.635	5.635	-	-	-	-
Critical Hdwy Stg 2	6.53	5.53	-	6.235	5.635	-	-	-	-
Follow-up Hdwy	3.519	4.019	3.319	3.5855	4.0855	3.3855	2.227	-	-
Pot Cap-1 Maneuver	824	745	917	798	731	1052	1447	-	0
Stage 1	871	787	-	985	869	-	-	-	0
Stage 2	1014	884	-	853	772	-	-	-	0
Platoon blocked, %								-	
Mov Cap-1 Maneuver	657	745	917	299	731	1052	1447	-	-
Mov Cap-2 Maneuver	657	745	-	299	731	-	-	-	-
Stage 1	871	787	-	985	869	-	-	-	-
Stage 2	808	884	-	320	772	-	-	-	-

Approach	EB	WB	NB
HCM Control Delay, s	15.2	9.3	
HCM LOS	C	A	

Minor Lane/Major Mvmt	NBL	NBT	EBLn1	WBLn1	SBL	SBT
Capacity (veh/h)	1447	-	917	1052	1588	-
HCM Lane V/C Ratio	-	-	0.625	0.203	-	-
HCM Control Delay (s)	0	-	15.2	9.3	0	-
HCM Lane LOS	A	-	C	A	A	-
HCM 95th %tile Q(veh)	0	-	5	1	0	-

Intersection	
Int Delay, s/veh	

Movement	SBL	SBT	SBR
Vol, veh/h	0	119	204
Conflicting Peds, #/hr	0	0	0
Sign Control	Free	Free	Free
RT Channelized	-	-	Free
Storage Length	-	-	-
Veh in Median Storage, #	-	0	-
Grade, %	-	0	-
Peak Hour Factor	90	90	90
Heavy Vehicles, %	4	4	4
Mvmt Flow	0	132	227

Major/Minor	Major2		
Conflicting Flow All	14	0	0
Stage 1	-	-	-
Stage 2	-	-	-
Critical Hdwy	4.18	-	-
Critical Hdwy Stg 1	-	-	-
Critical Hdwy Stg 2	-	-	-
Follow-up Hdwy	2.24	-	-
Pot Cap-1 Maneuver	1588	-	0
Stage 1	-	-	0
Stage 2	-	-	0
Platoon blocked, %		-	
Mov Cap-1 Maneuver	1588	-	-
Mov Cap-2 Maneuver	-	-	-
Stage 1	-	-	-
Stage 2	-	-	-

Approach	SB
HCM Control Delay, s	
HCM LOS	

Minor Lane/Major Mvmt

Intersection	
Int Delay, s/veh	1.2

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Vol, veh/h	22	212	15	29	284	27
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Stop	Stop	Free	Free
RT Channelized	-	Free	-	None	-	Yield
Storage Length	-	0	-	-	0	0
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	90	90	90	90	90	90
Heavy Vehicles, %	3	3	10	10	4	4
Mvmt Flow	24	236	17	32	316	30

Major/Minor	Major1		Minor2		Major2	
Conflicting Flow All	0	-	24	655	24	-
Stage 1	-	-	0	631	-	-
Stage 2	-	-	24	24	-	-
Critical Hdwy	-	-	6.5	6.6	4.14	-
Critical Hdwy Stg 1	-	-	-	-	-	-
Critical Hdwy Stg 2	-	-	5.5	5.6	-	-
Follow-up Hdwy	-	-	3.59	4.09	2.236	-
Pot Cap-1 Maneuver	-	0	972	376	1578	-
Stage 1	-	0	-	-	-	-
Stage 2	-	0	978	860	-	-
Platoon blocked, %	-					-
Mov Cap-1 Maneuver	-	-	777	0	1578	-
Mov Cap-2 Maneuver	-	-	777	0	-	-
Stage 1	-	-	-	0	-	-
Stage 2	-	-	978	0	-	-

Approach	EB	WB	NB
HCM Control Delay, s		9.9	
HCM LOS		A	

Minor Lane/Major Mvmt	NBL	NBR	EBT	WBLn1
Capacity (veh/h)	1578	-	-	777
HCM Lane V/C Ratio	0.2	-	-	0.063
HCM Control Delay (s)	7.9	-	-	9.9
HCM Lane LOS	A	-	-	A
HCM 95th %tile Q(veh)	1	-	-	0

Intersection	
Int Delay, s/veh	1.3

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Vol, veh/h	31	302	21	18	181	24
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Stop	Stop	Free	Free
RT Channelized	-	Free	-	None	-	Yield
Storage Length	-	0	-	-	0	0
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	90	90	90	90	90	90
Heavy Vehicles, %	2	2	9	9	4	4
Mvmt Flow	34	336	23	20	201	27

Major/Minor	Major1		Minor2		Major2	
Conflicting Flow All	0	-	34	436	34	-
Stage 1	-	-	0	402	-	-
Stage 2	-	-	34	34	-	-
Critical Hdwy	-	-	6.49	6.59	4.14	-
Critical Hdwy Stg 1	-	-	-	-	-	-
Critical Hdwy Stg 2	-	-	5.49	5.59	-	-
Follow-up Hdwy	-	-	3.581	4.081	2.236	-
Pot Cap-1 Maneuver	-	0	962	503	1565	-
Stage 1	-	0	-	-	-	-
Stage 2	-	0	971	853	-	-
Platoon blocked, %	-					-
Mov Cap-1 Maneuver	-	-	838	0	1565	-
Mov Cap-2 Maneuver	-	-	838	0	-	-
Stage 1	-	-	-	0	-	-
Stage 2	-	-	971	0	-	-

Approach	EB	WB	NB
HCM Control Delay, s		9.5	
HCM LOS		A	

Minor Lane/Major Mvmt	NBL	NBR	EBT	WBLn1
Capacity (veh/h)	1565	-	-	838
HCM Lane V/C Ratio	0.129	-	-	0.052
HCM Control Delay (s)	7.6	-	-	9.5
HCM Lane LOS	A	-	-	A
HCM 95th %tile Q(veh)	0	-	-	0

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	7	661	110	34	247	4	162	4	101	4	4	5
Number	7	4	14	3	8	18	5	2	12	1	6	16
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1727	1727	1727	1696	1696	1900	1863	1863	1900	1863	1863	1900
Adj Flow Rate, veh/h	8	734	122	38	274	4	180	4	112	4	4	6
Adj No. of Lanes	1	2	1	1	2	0	1	2	0	1	2	0
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Percent Heavy Veh, %	10	10	10	12	12	12	2	2	2	2	2	2
Cap, veh/h	438	1202	538	233	1191	17	780	828	741	669	828	741
Arrive On Green	0.37	0.37	0.37	0.37	0.37	0.37	0.47	0.47	0.47	0.47	0.47	0.47
Sat Flow, veh/h	1017	3282	1468	585	3252	47	1399	1770	1583	1271	1770	1583
Grp Volume(v), veh/h	8	734	122	38	136	142	180	4	112	4	4	6
Grp Sat Flow(s),veh/h/ln	1017	1641	1468	585	1612	1688	1399	1770	1583	1271	1770	1583
Q Serve(g_s), s	0.3	10.5	3.3	3.3	3.4	3.4	4.5	0.1	2.3	0.1	0.1	0.1
Cycle Q Clear(g_c), s	3.7	10.5	3.3	13.8	3.4	3.4	4.5	0.1	2.3	2.4	0.1	0.1
Prop In Lane	1.00		1.00	1.00		0.03	1.00		1.00	1.00		1.00
Lane Grp Cap(c), veh/h	438	1202	538	233	590	618	780	828	741	669	828	741
V/C Ratio(X)	0.02	0.61	0.23	0.16	0.23	0.23	0.23	0.00	0.15	0.01	0.00	0.01
Avail Cap(c_a), veh/h	525	1483	663	283	728	763	780	828	741	669	828	741
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	13.9	14.9	12.6	20.5	12.6	12.6	9.3	8.2	8.8	9.5	8.2	8.2
Incr Delay (d2), s/veh	0.0	0.5	0.2	0.3	0.2	0.2	0.7	0.0	0.4	0.0	0.0	0.0
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	0.1	4.8	1.4	0.5	1.5	1.6	1.9	0.0	1.1	0.0	0.0	0.1
LnGrp Delay(d),s/veh	13.9	15.4	12.8	20.8	12.8	12.8	10.0	8.2	9.2	9.5	8.2	8.2
LnGrp LOS	B	B	B	C	B	B	B	A	A	A	A	A
Approach Vol, veh/h		864			316			296			14	
Approach Delay, s/veh		15.0			13.8			9.7			8.6	
Approach LOS		B			B			A			A	

Timer	1	2	3	4	5	6	7	8
Assigned Phs		2		4		6		8
Phs Duration (G+Y+Rc), s		32.9		27.1		32.9		27.1
Change Period (Y+Rc), s		6.0		6.0		6.0		6.0
Max Green Setting (Gmax), s		22.0		26.0		22.0		26.0
Max Q Clear Time (g_c+I1), s		7.5		12.5		4.4		15.8
Green Ext Time (p_c), s		1.1		6.3		1.1		5.3

Intersection Summary	
HCM 2010 Ctrl Delay	13.6
HCM 2010 LOS	B

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	5	255	159	105	557	4	129	4	12	4	4	9
Number	7	4	14	3	8	18	5	2	12	1	6	16
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1727	1727	1727	1712	1712	1900	1863	1863	1900	1863	1863	1900
Adj Flow Rate, veh/h	6	283	177	117	619	4	143	4	13	4	4	10
Adj No. of Lanes	1	2	1	1	2	0	1	2	0	1	2	0
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Percent Heavy Veh, %	10	10	10	11	11	11	2	2	2	2	2	2
Cap, veh/h	249	1051	470	346	1061	7	864	935	837	856	935	837
Arrive On Green	0.32	0.32	0.32	0.32	0.32	0.32	0.53	0.53	0.53	0.53	0.53	0.53
Sat Flow, veh/h	740	3282	1468	853	3313	21	1394	1770	1583	1390	1770	1583
Grp Volume(v), veh/h	6	283	177	117	304	319	143	4	13	4	4	10
Grp Sat Flow(s),veh/h/ln	740	1641	1468	853	1626	1708	1394	1770	1583	1390	1770	1583
Q Serve(g_s), s	0.4	3.6	5.3	6.7	8.8	8.8	3.0	0.1	0.2	0.1	0.1	0.2
Cycle Q Clear(g_c), s	9.2	3.6	5.3	10.3	8.8	8.8	3.0	0.1	0.2	0.3	0.1	0.2
Prop In Lane	1.00		1.00	1.00		0.01	1.00		1.00	1.00		1.00
Lane Grp Cap(c), veh/h	249	1051	470	346	521	547	864	935	837	856	935	837
V/C Ratio(X)	0.02	0.27	0.38	0.34	0.58	0.58	0.17	0.00	0.02	0.00	0.00	0.01
Avail Cap(c_a), veh/h	339	1451	649	450	719	755	864	935	837	856	935	837
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	19.9	14.3	14.9	18.1	16.1	16.1	7.0	6.3	6.3	6.4	6.3	6.3
Incr Delay (d2), s/veh	0.0	0.1	0.5	0.6	1.0	1.0	0.4	0.0	0.0	0.0	0.0	0.0
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	0.1	1.7	2.2	1.6	4.1	4.3	1.3	0.0	0.1	0.0	0.0	0.1
LnGrp Delay(d),s/veh	20.0	14.4	15.4	18.7	17.1	17.1	7.4	6.3	6.4	6.4	6.3	6.4
LnGrp LOS	B	B	B	B	B	B	A	A	A	A	A	A
Approach Vol, veh/h		466			740			160			18	
Approach Delay, s/veh		14.9			17.3			7.3			6.4	
Approach LOS		B			B			A			A	

Timer	1	2	3	4	5	6	7	8
Assigned Phs		2		4		6		8
Phs Duration (G+Y+Rc), s		35.9		24.1		35.9		24.1
Change Period (Y+Rc), s		6.0		6.0		6.0		6.0
Max Green Setting (Gmax), s		23.0		25.0		23.0		25.0
Max Q Clear Time (g_c+I1), s		6.0		11.2		2.3		12.3
Green Ext Time (p_c), s		0.5		6.1		0.5		5.8

Intersection Summary	
HCM 2010 Ctrl Delay	15.2
HCM 2010 LOS	B

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Volume (veh/h)	66	6	5	201	104	44
Number	7	14	5	2	6	16
Initial Q (Qb), veh	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00	1.00	1.00			1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1863	1863	1863	1863	1863	1900
Adj Flow Rate, veh/h	73	7	6	223	116	49
Adj No. of Lanes	2	1	1	2	2	0
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90
Percent Heavy Veh, %	2	2	2	2	2	2
Cap, veh/h	400	184	1069	2726	1898	764
Arrive On Green	0.12	0.12	0.77	0.77	0.77	0.77
Sat Flow, veh/h	3442	1583	1216	3632	2558	993
Grp Volume(v), veh/h	73	7	6	223	82	83
Grp Sat Flow(s),veh/h/ln	1721	1583	1216	1770	1770	1688
Q Serve(g_s), s	1.0	0.2	0.1	0.8	0.6	0.6
Cycle Q Clear(g_c), s	1.0	0.2	0.1	0.8	0.6	0.6
Prop In Lane	1.00	1.00	1.00			0.59
Lane Grp Cap(c), veh/h	400	184	1069	2726	1363	1300
V/C Ratio(X)	0.18	0.04	0.01	0.08	0.06	0.06
Avail Cap(c_a), veh/h	1144	526	1069	2726	1363	1300
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	1.00	1.00	0.99	0.99
Uniform Delay (d), s/veh	21.6	21.2	1.4	1.5	1.5	1.5
Incr Delay (d2), s/veh	0.2	0.1	0.0	0.1	0.1	0.1
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	0.5	0.1	0.0	0.4	0.3	0.3
LnGrp Delay(d),s/veh	21.8	21.3	1.4	1.6	1.6	1.6
LnGrp LOS	C	C	A	A	A	A
Approach Vol, veh/h	80			229	165	
Approach Delay, s/veh	21.8			1.6	1.6	
Approach LOS	C			A	A	

Timer	1	2	3	4	5	6	7	8
Assigned Phs		2		4		6		
Phs Duration (G+Y+Rc), s		47.7		12.3		47.7		
Change Period (Y+Rc), s		6.0		6.0		6.0		
Max Green Setting (Gmax), s		30.0		18.0		30.0		
Max Q Clear Time (g_c+I1), s		3.1		3.0		2.6		
Green Ext Time (p_c), s		2.4		0.2		2.4		

Intersection Summary	
HCM 2010 Ctrl Delay	5.0
HCM 2010 LOS	A

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Volume (veh/h)	37	5	5	108	208	60
Number	7	14	5	2	6	16
Initial Q (Qb), veh	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00	1.00	1.00			1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1863	1863	1863	1863	1863	1900
Adj Flow Rate, veh/h	41	6	6	120	231	67
Adj No. of Lanes	2	1	1	2	2	0
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90
Percent Heavy Veh, %	2	2	2	2	2	2
Cap, veh/h	291	134	1004	2861	2202	624
Arrive On Green	0.08	0.08	0.81	0.81	1.00	1.00
Sat Flow, veh/h	3442	1583	1077	3632	2817	772
Grp Volume(v), veh/h	41	6	6	120	148	150
Grp Sat Flow(s),veh/h/ln	1721	1583	1077	1770	1770	1727
Q Serve(g_s), s	0.6	0.2	0.1	0.4	0.0	0.0
Cycle Q Clear(g_c), s	0.6	0.2	0.1	0.4	0.0	0.0
Prop In Lane	1.00	1.00	1.00			0.45
Lane Grp Cap(c), veh/h	291	134	1004	2861	1430	1395
V/C Ratio(X)	0.14	0.04	0.01	0.04	0.10	0.11
Avail Cap(c_a), veh/h	1088	501	1004	2861	1430	1395
HCM Platoon Ratio	1.00	1.00	1.00	1.00	2.00	2.00
Upstream Filter(I)	1.00	1.00	1.00	1.00	0.96	0.96
Uniform Delay (d), s/veh	22.8	22.6	1.0	1.0	0.0	0.0
Incr Delay (d2), s/veh	0.2	0.1	0.0	0.0	0.1	0.1
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	0.3	0.1	0.0	0.2	0.1	0.1
LnGrp Delay(d),s/veh	23.0	22.8	1.0	1.1	0.1	0.1
LnGrp LOS	C	C	A	A	A	A
Approach Vol, veh/h	47			126	298	
Approach Delay, s/veh	23.0			1.0	0.1	
Approach LOS	C			A	A	

Timer	1	2	3	4	5	6	7	8
Assigned Phs		2		4		6		
Phs Duration (G+Y+Rc), s		49.5		10.5		49.5		
Change Period (Y+Rc), s		6.0		6.0		6.0		
Max Green Setting (Gmax), s		31.0		17.0		31.0		
Max Q Clear Time (g_c+I1), s		3.1		2.6		2.0		
Green Ext Time (p_c), s		2.5		0.1		2.6		

Intersection Summary	
HCM 2010 Ctrl Delay	2.7
HCM 2010 LOS	A

Intersection	
Int Delay, s/veh	0.1

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Vol, veh/h	0	0	4	206	8	102
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	0	-	-	-	-	-
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	90	90	90	90	90	90
Heavy Vehicles, %	2	2	2	2	2	2
Mvmt Flow	0	0	4	229	9	113

Major/Minor	Minor2		Major1		Major2	
Conflicting Flow All	189	61	122	0	-	0
Stage 1	66	-	-	-	-	-
Stage 2	123	-	-	-	-	-
Critical Hdwy	6.84	6.94	4.14	-	-	-
Critical Hdwy Stg 1	5.84	-	-	-	-	-
Critical Hdwy Stg 2	5.84	-	-	-	-	-
Follow-up Hdwy	3.52	3.32	2.22	-	-	-
Pot Cap-1 Maneuver	782	991	1463	-	-	-
Stage 1	949	-	-	-	-	-
Stage 2	889	-	-	-	-	-
Platoon blocked, %				-	-	-
Mov Cap-1 Maneuver	780	991	1463	-	-	-
Mov Cap-2 Maneuver	780	-	-	-	-	-
Stage 1	949	-	-	-	-	-
Stage 2	886	-	-	-	-	-

Approach	EB	NB	SB
HCM Control Delay, s	0	0.1	
HCM LOS	A		

Minor Lane/Major Mvmt	NBL	NBT	EBLn1	SBT	SBR
Capacity (veh/h)	1463	-	-	-	-
HCM Lane V/C Ratio	0.003	-	-	-	-
HCM Control Delay (s)	7.5	0	0	-	-
HCM Lane LOS	A	A	A	-	-
HCM 95th %tile Q(veh)	0	-	-	-	-

Intersection	
Int Delay, s/veh	0.1

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Vol, veh/h	0	0	4	113	8	205
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	0	-	-	-	-	-
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	90	90	90	90	90	90
Heavy Vehicles, %	2	2	2	2	2	2
Mvmt Flow	0	0	4	126	9	228

Major/Minor	Minor2		Major1		Major2	
Conflicting Flow All	195	118	237	0	-	0
Stage 1	123	-	-	-	-	-
Stage 2	72	-	-	-	-	-
Critical Hdwy	6.84	6.94	4.14	-	-	-
Critical Hdwy Stg 1	5.84	-	-	-	-	-
Critical Hdwy Stg 2	5.84	-	-	-	-	-
Follow-up Hdwy	3.52	3.32	2.22	-	-	-
Pot Cap-1 Maneuver	776	912	1327	-	-	-
Stage 1	889	-	-	-	-	-
Stage 2	942	-	-	-	-	-
Platoon blocked, %				-	-	-
Mov Cap-1 Maneuver	774	912	1327	-	-	-
Mov Cap-2 Maneuver	774	-	-	-	-	-
Stage 1	889	-	-	-	-	-
Stage 2	939	-	-	-	-	-

Approach	EB	NB	SB
HCM Control Delay, s	0	0.3	
HCM LOS	A		

Minor Lane/Major Mvmt	NBL	NBT	EBLn1	SBT	SBR
Capacity (veh/h)	1327	-	-	-	-
HCM Lane V/C Ratio	0.003	-	-	-	-
HCM Control Delay (s)	7.7	0	0	-	-
HCM Lane LOS	A	A	A	-	-
HCM 95th %tile Q(veh)	0	-	-	-	-

Intersection	
Int Delay, s/veh	9.1

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR
Vol, veh/h	202	4	4	4	0	4	0	4	4
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0
Sign Control	Stop	Stop	Stop	Stop	Stop	Stop	Free	Free	Free
RT Channelized	-	-	None	-	-	None	-	-	None
Storage Length	-	-	-	-	-	-	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-
Peak Hour Factor	90	90	90	90	90	90	90	90	90
Heavy Vehicles, %	2	2	2	2	2	2	2	2	2
Mvmt Flow	224	4	4	4	0	4	0	4	4

Major/Minor	Minor2			Minor1			Major1		
Conflicting Flow All	22	22	4	25	20	7	4	0	0
Stage 1	13	13	-	7	7	-	-	-	-
Stage 2	9	9	-	18	13	-	-	-	-
Critical Hdwy	7.12	6.52	6.22	7.12	6.52	6.22	4.12	-	-
Critical Hdwy Stg 1	6.12	5.52	-	6.12	5.52	-	-	-	-
Critical Hdwy Stg 2	6.12	5.52	-	6.12	5.52	-	-	-	-
Follow-up Hdwy	3.518	4.018	3.318	3.518	4.018	3.318	2.218	-	-
Pot Cap-1 Maneuver	990	872	1080	986	874	1075	1618	-	-
Stage 1	1007	885	-	1015	890	-	-	-	-
Stage 2	1012	888	-	1001	885	-	-	-	-
Platoon blocked, %								-	-
Mov Cap-1 Maneuver	984	870	1080	976	872	1075	1618	-	-
Mov Cap-2 Maneuver	984	870	-	976	872	-	-	-	-
Stage 1	1007	883	-	1015	890	-	-	-	-
Stage 2	1008	888	-	989	883	-	-	-	-

Approach	EB	WB	NB
HCM Control Delay, s	9.8	8.6	
HCM LOS	A	A	

Minor Lane/Major Mvmt	NBL	NBT	NBR	EBLn1	WBLn1	SBL	SBT	SBR
Capacity (veh/h)	1618	-	-	983	1023	1611	-	-
HCM Lane V/C Ratio	-	-	-	0.237	0.009	0.003	-	-
HCM Control Delay (s)	0	-	-	9.8	8.6	7.2	-	-
HCM Lane LOS	A	-	-	A	A	A	-	-
HCM 95th %tile Q(veh)	0	-	-	1	0	0	-	-

Intersection	
Int Delay, s/veh	

Movement	SBL	SBT	SBR
Vol, veh/h	4	4	0
Conflicting Peds, #/hr	0	0	0
Sign Control	Free	Free	Free
RT Channelized	-	-	None
Storage Length	0	-	-
Veh in Median Storage, #	-	0	-
Grade, %	-	0	-
Peak Hour Factor	90	90	90
Heavy Vehicles, %	2	2	2
Mvmt Flow	4	4	0

Major/Minor	Major2		
Conflicting Flow All	9	0	0
Stage 1	-	-	-
Stage 2	-	-	-
Critical Hdwy	4.12	-	-
Critical Hdwy Stg 1	-	-	-
Critical Hdwy Stg 2	-	-	-
Follow-up Hdwy	2.218	-	-
Pot Cap-1 Maneuver	1611	-	-
Stage 1	-	-	-
Stage 2	-	-	-
Platoon blocked, %		-	-
Mov Cap-1 Maneuver	1611	-	-
Mov Cap-2 Maneuver	-	-	-
Stage 1	-	-	-
Stage 2	-	-	-

Approach	SB
HCM Control Delay, s	
HCM LOS	

Minor Lane/Major Mvmt

Intersection	
Int Delay, s/veh	8

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR
Vol, veh/h	107	4	4	4	0	4	0	6	4
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0
Sign Control	Stop	Stop	Stop	Stop	Stop	Stop	Free	Free	Free
RT Channelized	-	-	None	-	-	None	-	-	None
Storage Length	-	-	-	-	-	-	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-
Peak Hour Factor	90	90	90	90	90	90	90	90	90
Heavy Vehicles, %	2	2	2	2	2	2	2	2	2
Mvmt Flow	119	4	4	4	0	4	0	7	4

Major/Minor	Minor2			Minor1			Major1		
Conflicting Flow All	24	24	4	27	22	9	4	0	0
Stage 1	13	13	-	9	9	-	-	-	-
Stage 2	11	11	-	18	13	-	-	-	-
Critical Hdwy	7.12	6.52	6.22	7.12	6.52	6.22	4.12	-	-
Critical Hdwy Stg 1	6.12	5.52	-	6.12	5.52	-	-	-	-
Critical Hdwy Stg 2	6.12	5.52	-	6.12	5.52	-	-	-	-
Follow-up Hdwy	3.518	4.018	3.318	3.518	4.018	3.318	2.218	-	-
Pot Cap-1 Maneuver	987	869	1080	983	872	1073	1618	-	-
Stage 1	1007	885	-	1012	888	-	-	-	-
Stage 2	1010	886	-	1001	885	-	-	-	-
Platoon blocked, %								-	-
Mov Cap-1 Maneuver	981	867	1080	973	870	1073	1618	-	-
Mov Cap-2 Maneuver	981	867	-	973	870	-	-	-	-
Stage 1	1007	883	-	1012	888	-	-	-	-
Stage 2	1006	886	-	989	883	-	-	-	-

Approach	EB	WB	NB
HCM Control Delay, s	9.2	8.6	
HCM LOS	A	A	

Minor Lane/Major Mvmt	NBL	NBT	NBR	EBLn1	WBLn1	SBL	SBT	SBR
Capacity (veh/h)	1618	-	-	980	1021	1608	-	-
HCM Lane V/C Ratio	-	-	-	0.13	0.009	0.003	-	-
HCM Control Delay (s)	0	-	-	9.2	8.6	7.2	-	-
HCM Lane LOS	A	-	-	A	A	A	-	-
HCM 95th %tile Q(veh)	0	-	-	0	0	0	-	-

Intersection			
Int Delay, s/veh			

Movement	SBL	SBT	SBR
Vol, veh/h	4	4	0
Conflicting Peds, #/hr	0	0	0
Sign Control	Free	Free	Free
RT Channelized	-	-	None
Storage Length	0	-	-
Veh in Median Storage, #	-	0	-
Grade, %	-	0	-
Peak Hour Factor	90	90	90
Heavy Vehicles, %	2	2	2
Mvmt Flow	4	4	0

Major/Minor	Major2		
Conflicting Flow All	11	0	0
Stage 1	-	-	-
Stage 2	-	-	-
Critical Hdwy	4.12	-	-
Critical Hdwy Stg 1	-	-	-
Critical Hdwy Stg 2	-	-	-
Follow-up Hdwy	2.218	-	-
Pot Cap-1 Maneuver	1608	-	-
Stage 1	-	-	-
Stage 2	-	-	-
Platoon blocked, %		-	-
Mov Cap-1 Maneuver	1608	-	-
Mov Cap-2 Maneuver	-	-	-
Stage 1	-	-	-
Stage 2	-	-	-

Approach	SB
HCM Control Delay, s	
HCM LOS	

Minor Lane/Major Mvmt

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	Cosgrove NB
Agency or Company	Atkins	Junction	7010 - Off to I-26 EB
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2018 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Freeway Number of Lanes, N	3	Downstream Adj Ramp	
☐ Yes	☐ On	Ramp Number of Lanes, N	1	☐ Yes	☐ On
☑ No	☐ Off	Acceleration Lane Length, L_A		☑ No	☐ Off
L_{up} =	ft	Deceleration Lane Length L_D	125	L_{down} =	ft
V_u =	veh/h	Freeway Volume, V_F	2900	V_D =	veh/h
		Ramp Volume, V_R	849		
		Freeway Free-Flow Speed, S_{FF}	55.0		
		Ramp Free-Flow Speed, S_{FR}	45.0		

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	2900	0.90	Level	10	0	0.952	1.00	3383
Ramp	849	0.90	Level	12	0	0.943	1.00	1000
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 0.629 using Equation (Exhibit 13-7)

V_{12} = 2500 pc/h

V_3 or V_{av34} 883 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	3383	Exhibit 13-8	6750	No
$V_{FO} = V_F - V_R$	2383	Exhibit 13-8	6750	No
V_R	1000	Exhibit 13-10	2100	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	2500	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = 24.6 (pc/mi/ln)

LOS = C (Exhibit 13-2)

Speed Determination

D_s = 0.388 (Exhibit 13-12)

S_R= 50.0 mph (Exhibit 13-12)

S_0= 60.3 mph (Exhibit 13-12)

S = 52.3 mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	Cosgrove NB
Agency or Company	Atkins	Junction	7010 - Off to I-26 EB
Date Performed	3/20/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2018 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Freeway Number of Lanes, N: 3	☐ Yes ☐ On
☑ No ☐ Off	Ramp Number of Lanes, N: 1	☑ No ☐ Off
L_{up} = ft	Acceleration Lane Length, L_A	L_{down} = ft
V_u = veh/h	Deceleration Lane Length L_D: 125	V_D = veh/h
	Freeway Volume, V_F: 1928	
	Ramp Volume, V_R: 456	
	Freeway Free-Flow Speed, S_{FF}: 55.0	
	Ramp Free-Flow Speed, S_{FR}: 45.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	1928	0.90	Level	8	0	0.962	1.00	2228
Ramp	456	0.90	Level	19	0	0.913	1.00	555
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 0.679 using Equation (Exhibit 13-7)

V_{12} = 1691 pc/h

V_3 or V_{av34} 537 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	2228	Exhibit 13-8	6750	No
$V_{FO} = V_F - V_R$	1673	Exhibit 13-8	6750	No
V_R	555	Exhibit 13-10	2100	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	1691	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = 17.7 (pc/mi/ln)

LOS = B (Exhibit 13-2)

Speed Determination

D_s = 0.348 (Exhibit 13-12)

S_R= 50.5 mph (Exhibit 13-12)

S_0= 60.3 mph (Exhibit 13-12)

S = 52.5 mph (Exhibit 13-13)

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Navy Base ICTF

FREEWAY WEAVING WORKSHEET

General Information

Analyst	AJR
Agency/Company	Atkins
Date Performed	7/25/2014
Analysis Time Period	AM Peak

Site Information

Freeway/Dir of Travel	Cosgrove NB
Weaving Segment Location	7020-I-26 EB On to I-26 WB Off
Analysis Year	2018 No Action

Project Description *Navy Base ICTF*

Inputs

Weaving configuration	One-Sided
Weaving number of lanes, N	4
Weaving segment length, L_S	450ft
Freeway free-flow speed, FFS	45 mph
Segment type	C-D Roadway/ Multilane Highways
Freeway minimum speed, S_{MIN}	15
Freeway maximum capacity, C_{IFL}	2250
Terrain type	Level

Conversions to pc/h Under Base Conditions

	V (veh/h)	PHF	Truck (%)	RV (%)	E_T	E_R	f_{HV}	f_p	v (pc/h)
V_{FF}	1187	0.90	9	0	1.5	1.2	0.957	1.00	1378
V_{RF}	298	0.90	9	0	1.5	1.2	0.957	1.00	346
V_{FR}	864	0.90	19	0	1.5	1.2	0.913	1.00	1051
V_{RR}	0	0.90	0	0	1.5	1.2	1.000	1.00	0
V_{NW}	1378							V =	2775
V_W	1397								
VR	0.503								

Configuration Characteristics

Minimum maneuver lanes, N_{WL}	2 lc	Minimum weaving lane changes, LC_{MIN}	1397 lc/h
Interchange density, ID	0.2 int/mi	Weaving lane changes, LC_W	1485 lc/h
Minimum RF lane changes, LC_{RF}	1 lc/pc	Non-weaving lane changes, LC_{NW}	0 lc/h
Minimum FR lane changes, LC_{FR}	1 lc/pc	Total lane changes, LC_{ALL}	1485 lc/h
Minimum RR lane changes, LC_{RR}	lc/pc	Non-weaving vehicle index, I_{NW}	12

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment flow rate, v	2775 pc/h	Weaving intensity factor, W	0.580
Weaving segment capacity, c_w	4562 veh/h	Weaving segment speed, S	32.8 mph
Weaving segment v/c ratio	0.582	Average weaving speed, S_W	34.0 mph
Weaving segment density, D	21.2 pc/mi/ln	Average non-weaving speed, S_{NW}	31.6 mph
Level of Service, LOS	B	Maximum weaving length, L_{MAX}	7866 ft

Notes

a. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments".
b. For volumes that exceed the weaving segment capacity, the level of service is "F".

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Navy Base ICTF

FREEWAY WEAVING WORKSHEET

General Information

Analyst	AJR
Agency/Company	Atkins
Date Performed	7/25/2014
Analysis Time Period	PM Peak

Site Information

Freeway/Dir of Travel	Cosgrove NB
Weaving Segment Location	7020-I-26 EB On to I-26 WB Off
Analysis Year	2018 No Action

Project Description *Navy Base ICTF*

Inputs

Weaving configuration	One-Sided
Weaving number of lanes, N	4
Weaving segment length, L_S	450ft
Freeway free-flow speed, FFS	45 mph
Segment type	C-D Roadway/ Multilane Highways
Freeway minimum speed, S_{MIN}	15
Freeway maximum capacity, C_{IFL}	2250
Terrain type	Level

Conversions to pc/h Under Base Conditions

	V (veh/h)	PHF	Truck (%)	RV (%)	E_T	E_R	f_{HV}	f_p	v (pc/h)
V_{FF}	692	0.90	7	0	1.5	1.2	0.966	1.00	796
V_{RF}	138	0.90	14	0	1.5	1.2	0.935	1.00	164
V_{FR}	780	0.90	18	0	1.5	1.2	0.917	1.00	945
V_{RR}	0	0.90	0	0	1.5	1.2	1.000	1.00	0
V_{NW}	796							V =	1905
V_W	1109								
VR	0.582								

Configuration Characteristics

Minimum maneuver lanes, N_{WL}	2 lc	Minimum weaving lane changes, LC_{MIN}	1109 lc/h
Interchange density, ID	0.2 int/mi	Weaving lane changes, LC_W	1197 lc/h
Minimum RF lane changes, LC_{RF}	1 lc/pc	Non-weaving lane changes, LC_{NW}	0 lc/h
Minimum FR lane changes, LC_{FR}	1 lc/pc	Total lane changes, LC_{ALL}	1197 lc/h
Minimum RR lane changes, LC_{RR}	lc/pc	Non-weaving vehicle index, I_{NW}	7

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment flow rate, v	1905 pc/h	Weaving intensity factor, W	0.489
Weaving segment capacity, c_w	3983 veh/h	Weaving segment speed, S	35.0 mph
Weaving segment v/c ratio	0.462	Average weaving speed, S_W	35.1 mph
Weaving segment density, D	13.6 pc/mi/ln	Average non-weaving speed, S_{NW}	34.7 mph
Level of Service, LOS	B	Maximum weaving length, L_{MAX}	8802 ft

Notes

a. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments".
b. For volumes that exceed the weaving segment capacity, the level of service is "F".

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	Cosgrove NB
Agency or Company	Atkins	Junction	7030 - NB On from I-26 WB
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2018 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Number of Lanes, N: 3	☐ Yes ☐ On
☑ No ☐ Off	Acceleration Lane Length, L_A: 200	☑ No ☐ Off
L_{up} = ft	Deceleration Lane Length L_D:	L_{down} = ft
V_u = veh/h	Freeway Volume, V_F: 1485	V_D = veh/h
	Ramp Volume, V_R: 414	
	Freeway Free-Flow Speed, S_{FF}: 55.0	
	Ramp Free-Flow Speed, S_{FR}: 45.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	1485	0.90	Level	9	0	0.957	1.00	1724
Ramp	414	0.90	Level	9	0	0.957	1.00	481
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 0.583 using Equation (Exhibit 13-6)

V_{12} = 1005 pc/h

V_3 or V_{av34} 719 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * $V_{12}/2$ ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	2205	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	1486	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = 15.6 (pc/mi/ln)

LOS = B (Exhibit 13-2)

Speed Determination

M_S = 0.320 (Exibit 13-11)

S_R= 50.8 mph (Exhibit 13-11)

S_0= 54.2 mph (Exhibit 13-11)

S = 51.9 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * $V_{12}/2$ ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	Cosgrove NB
Agency or Company	Atkins	Junction	7030 - NB On from I-26 WB
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2018 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Number of Lanes, N: 3	☐ Yes ☐ On
☑ No ☐ Off	Acceleration Lane Length, L_A: 200	☑ No ☐ Off
L_{up} = ft	Deceleration Lane Length L_D	L_{down} = ft
V_u = veh/h	Freeway Volume, V_F: 830	V_D = veh/h
	Ramp Volume, V_R: 378	
	Freeway Free-Flow Speed, S_{FF}: 55.0	
	Ramp Free-Flow Speed, S_{FR}: 45.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	830	0.90	Level	7	0	0.966	1.00	954
Ramp	378	0.90	Level	9	0	0.957	1.00	439
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 0.583 using Equation (Exhibit 13-6)

V_{12} = 556 pc/h

V_3 or V_{av34} 398 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	1393	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	995	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = 11.8 (pc/mi/ln)

LOS = B (Exhibit 13-2)

Speed Determination

M_S = 0.314 (Exibit 13-11)

S_R= 50.9 mph (Exhibit 13-11)

S_0= 55.0 mph (Exhibit 13-11)

S = 52.0 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	Cosgrove SB
Agency or Company	Atkins	Junction	7040 - Off to I-26 WB
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2018 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Number of Lanes, N	2	Downstream Adj Ramp	
☐ Yes	☐ On	Acceleration Lane Length, L_A		☐ Yes	☐ On
☑ No	☐ Off	Deceleration Lane Length L_D	225	☑ No	☐ Off
L_{up} =	ft	Freeway Volume, V_F	1010	L_{down} =	ft
		Ramp Volume, V_R	151		
V_u =	veh/h	Freeway Free-Flow Speed, S_{FF}	55.0	V_D =	veh/h
		Ramp Free-Flow Speed, S_{FR}	45.0		

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	1010	0.90	Level	5	0	0.976	1.00	1150
Ramp	151	0.90	Level	21	0	0.905	1.00	185
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 1.000 using Equation (Exhibit 13-7)

V_{12} = 1150 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	1150	Exhibit 13-8	4500	No
$V_{FO} = V_F - V_R$	965	Exhibit 13-8	4500	No
V_R	185	Exhibit 13-10	2100	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	1150	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = 12.1 (pc/mi/ln)

LOS = B (Exhibit 13-2)

Speed Determination

D_s = 0.315 (Exhibit 13-12)

S_R= 50.9 mph (Exhibit 13-12)

S_0= N/A mph (Exhibit 13-12)

S = 50.9 mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	Cosgrove SB
Agency or Company	Atkins	Junction	7040 - Off to I-26 WB
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2018 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Number of Lanes, N	2	Downstream Adj Ramp	
☐ Yes	☐ On	Acceleration Lane Length, L_A		☐ Yes	☐ On
☑ No	☐ Off	Deceleration Lane Length L_D	225	☑ No	☐ Off
L_{up} =	ft	Freeway Volume, V_F	1790	L_{down} =	ft
		Ramp Volume, V_R	328		
		Freeway Free-Flow Speed, S_{FF}	55.0		
V_u =	veh/h	Ramp Free-Flow Speed, S_{FR}	45.0	V_D =	veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	1790	0.90	Level	4	0	0.980	1.00	2029
Ramp	328	0.90	Level	9	0	0.957	1.00	381
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 1.000 using Equation (Exhibit 13-7)

V_{12} = 2029 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	2029	Exhibit 13-8	4500	No
$V_{FO} = V_F - V_R$	1648	Exhibit 13-8	4500	No
V_R	381	Exhibit 13-10	2100	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	2029	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = 19.7 (pc/mi/ln)

LOS = B (Exhibit 13-2)

Speed Determination

D_s = 0.332 (Exhibit 13-12)

S_R= 50.7 mph (Exhibit 13-12)

S_0= N/A mph (Exhibit 13-12)

S = 50.7 mph (Exhibit 13-13)

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Navy Base ICTF

FREEWAY WEAVING WORKSHEET

General Information

Analyst	AJR
Agency/Company	Atkins
Date Performed	7/25/2014
Analysis Time Period	AM Peak

Site Information

Freeway/Dir of Travel	Cosgrove SB
Weaving Segment Location	7050-I-26 WB On to I-26 EB Off
Analysis Year	2018 No Action

Project Description *Navy Base ICTF*

Inputs

Weaving configuration	One-Sided
Weaving number of lanes, N	3
Weaving segment length, L_S	475ft
Freeway free-flow speed, FFS	45 mph
Segment type	C-D Roadway/ Multilane Highways
Freeway minimum speed, S_{MIN}	15
Freeway maximum capacity, C_{IFL}	2250
Terrain type	Level

Conversions to pc/h Under Base Conditions

	V (veh/h)	PHF	Truck (%)	RV (%)	E_T	E_R	f_{HV}	f_p	v (pc/h)
V_{FF}	436	0.90	9	0	1.5	1.2	0.957	1.00	506
V_{RF}	358	0.90	22	0	1.5	1.2	0.901	1.00	442
V_{FR}	423	0.90	9	0	1.5	1.2	0.957	1.00	491
V_{RR}	0	0.90	0	0	1.5	1.2	1.000	1.00	0
V_{NW}	506							V =	1439
V_W	933								
VR	0.648								

Configuration Characteristics

Minimum maneuver lanes, N_{WL}	2 lc	Minimum weaving lane changes, LC_{MIN}	933 lc/h
Interchange density, ID	0.2 int/mi	Weaving lane changes, LC_W	987 lc/h
Minimum RF lane changes, LC_{RF}	1 lc/pc	Non-weaving lane changes, LC_{NW}	0 lc/h
Minimum FR lane changes, LC_{FR}	1 lc/pc	Total lane changes, LC_{ALL}	987 lc/h
Minimum RR lane changes, LC_{RR}	lc/pc	Non-weaving vehicle index, I_{NW}	5

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment flow rate, v	1439 pc/h	Weaving intensity factor, W	0.402
Weaving segment capacity, c_w	3542 veh/h	Weaving segment speed, S	36.2 mph
Weaving segment v/c ratio	0.389	Average weaving speed, S_W	36.4 mph
Weaving segment density, D	13.2 pc/mi/ln	Average non-weaving speed, S_{NW}	36.0 mph
Level of Service, LOS	B	Maximum weaving length, L_{MAX}	9612 ft

Notes

a. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments".
b. For volumes that exceed the weaving segment capacity, the level of service is "F".

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Navy Base ICTF

FREEWAY WEAVING WORKSHEET

General Information

Analyst	AJR
Agency/Company	Atkins
Date Performed	7/25/2014
Analysis Time Period	PM Peak

Site Information

Freeway/Dir of Travel	Cosgrove SB
Weaving Segment Location	7050-I-26 WB On to I-26 EB Off
Analysis Year	2018 No Action

Project Description *Navy Base ICTF*

Inputs

Weaving configuration	One-Sided
Weaving number of lanes, N	3
Weaving segment length, L_S	475ft
Freeway free-flow speed, FFS	45 mph
Segment type	C-D Roadway/ Multilane Highways
Freeway minimum speed, S_{MIN}	15
Freeway maximum capacity, C_{IFL}	2250
Terrain type	Level

Conversions to pc/h Under Base Conditions

	V (veh/h)	PHF	Truck (%)	RV (%)	E_T	E_R	f_{HV}	f_p	v (pc/h)
V_{FF}	1042	0.90	7	0	1.5	1.2	0.966	1.00	1198
V_{RF}	833	0.90	8	0	1.5	1.2	0.962	1.00	963
V_{FR}	420	0.90	7	0	1.5	1.2	0.966	1.00	483
V_{RR}	0	0.90	0	0	1.5	1.2	1.000	1.00	0
V_{NW}	1198							V =	2644
V_W	1446								
VR	0.547								

Configuration Characteristics

Minimum maneuver lanes, N_{WL}	2 lc	Minimum weaving lane changes, LC_{MIN}	1446 lc/h
Interchange density, ID	0.2 int/mi	Weaving lane changes, LC_W	1500 lc/h
Minimum RF lane changes, LC_{RF}	1 lc/pc	Non-weaving lane changes, LC_{NW}	0 lc/h
Minimum FR lane changes, LC_{FR}	1 lc/pc	Total lane changes, LC_{ALL}	1500 lc/h
Minimum RR lane changes, LC_{RR}	lc/pc	Non-weaving vehicle index, I_{NW}	11

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment flow rate, v	2644 pc/h	Weaving intensity factor, W	0.560
Weaving segment capacity, c_w	4240 veh/h	Weaving segment speed, S	32.4 mph
Weaving segment v/c ratio	0.602	Average weaving speed, S_W	34.2 mph
Weaving segment density, D	27.2 pc/mi/ln	Average non-weaving speed, S_{NW}	30.4 mph
Level of Service, LOS	C	Maximum weaving length, L_{MAX}	8380 ft

Notes

a. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments".
b. For volumes that exceed the weaving segment capacity, the level of service is "F".

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RAMP ADD OR DROP LANE ANALYSIS (MAINLINE <55 MPH)

ATKINS

General Information

Date Performed:	7/25/2014	Freeway/Direction	Cosgrove SB
Analysis Year	2018 No Action	Junction	From I-26 EB
Analysis Time Period:	AM Peak	Segment ID	7060
Project Description:	Navy Base ICTF		

Inputs

	Mainline Upstream Ramp	Mainline Downstream Ramp	Ramp
Number of Lanes, N	2	3	1
Free-Flow Speed, FFS (mph)	45	45	45
Volume, V (veh/h)	794	1,594	800
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	10%	10%	11%
%RVs, P_R	0%	0%	0%

Performance Measures

	Upstream of Off-Ramp	Downstream of Off-Ramp	Off-Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.95	0.95	0.95
Demand Flow Rate, v_p (pc/h/ln)	463	620	938
Capacity Flow Rate, c (pc/h/ln)	2,100	2,100	2,100
v/c ratio	0.22	0.30	0.45
Density, D_{MD} (pc/mi/ln)	8.1	10.9	16.4
LOS	A	B	B

Formulas and Reference Material

$$f_{HV} = \frac{1}{1+P_T(E_T-1)+P_R(E_R-1)}$$ HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P}$$ HCM 2010, Equation 11-2

$$D_{MD} = \frac{0.0175*v_f}{N}$$ HCM 2010, Equation 13-26

Ramp Roadways Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

Diverge LOS Thresholds

LOS	Density (pc/mi/ln)
A	≤10
B	>10-20
C	>20-28
D	>28-35
E	>35
F	v/c > 1

Source: HCM 2010, Exhibit 13-2

RAMP ADD OR DROP LANE ANALYSIS (MAINLINE <55 MPH)

ATKINS

General Information

Date Performed:	7/25/2014	Freeway/Direction	Cosgrove SB
Analysis Year	2018 No Action	Junction	From I-26 EB
Analysis Time Period:	PM Peak	Segment ID	7060
Project Description:	Navy Base ICTF		

Inputs

	Mainline Upstream Ramp	Mainline Downstream Ramp	Ramp
Number of Lanes, N	2	3	1
Free-Flow Speed, FFS (mph)	45	45	45
Volume, V (veh/h)	1,875	3,035	1,160
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	8%	8%	7%
%RVs, P_R	0%	0%	0%

Performance Measures

	Upstream of Off-Ramp	Downstream of Off-Ramp	Off-Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.96	0.96	0.97
Demand Flow Rate, v_p (pc/h/ln)	1,083	1,169	1,334
Capacity Flow Rate, c (pc/h/ln)	2,100	2,100	2,100
v/c ratio	0.52	0.56	0.64
Density, D_{MD} (pc/mi/ln)	19.0	20.5	23.3
LOS	B	C	C

Formulas and Reference Material

$$f_{HV} = \frac{1}{1+P_T(E_T-1)+P_R(E_R-1)}$$ HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P}$$ HCM 2010, Equation 11-2

$$D_{MD} = \frac{0.0175*v_f}{N}$$ HCM 2010, Equation 13-26

Ramp Roadways Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

Diverge LOS Thresholds

LOS	Density (pc/mi/ln)
A	≤10
B	>10-20
C	>20-28
D	>28-35
E	>35
F	v/c > 1

Source: HCM 2010, Exhibit 13-2

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	Montague NB
Agency or Company	Atkins	Junction	8010 - Off to I-26 EB
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2018 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Number of Lanes, N	2	Downstream Adj Ramp	
☐ Yes	☐ On	Acceleration Lane Length, L_A		☐ Yes	☐ On
☑ No	☐ Off	Deceleration Lane Length L_D	350	☑ No	☐ Off
L_{up} =	ft	Freeway Volume, V_F	1791	L_{down} =	ft
V_u =	veh/h	Ramp Volume, V_R	558	V_D =	veh/h
		Freeway Free-Flow Speed, S_{FF}	55.0		
		Ramp Free-Flow Speed, S_{FR}	45.0		

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	1791	0.90	Level	9	0	0.957	1.00	2080
Ramp	558	0.90	Level	5	0	0.976	1.00	636
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 1.000 using Equation (Exhibit 13-7)

V_{12} = 2080 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	2080	Exhibit 13-8	4500	No
$V_{FO} = V_F - V_R$	1444	Exhibit 13-8	4500	No
V_R	636	Exhibit 13-10	2100	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	2080	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = 19.0 (pc/mi/ln)

LOS = B (Exhibit 13-2)

Speed Determination

D_s = 0.355 (Exhibit 13-12)

S_R= 50.4 mph (Exhibit 13-12)

S_0= N/A mph (Exhibit 13-12)

S = 50.4 mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	Montague NB
Agency or Company	Atkins	Junction	8010 - Off to I-26 EB
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2018 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Number of Lanes, N	2	Downstream Adj Ramp	
☐ Yes	☐ On	Acceleration Lane Length, L_A		☐ Yes	☐ On
☑ No	☐ Off	Deceleration Lane Length L_D	350	☑ No	☐ Off
L_{up} =	ft	Freeway Volume, V_F	1995	L_{down} =	ft
V_u =	veh/h	Ramp Volume, V_R	605	V_D =	veh/h
		Freeway Free-Flow Speed, S_{FF}	55.0		
		Ramp Free-Flow Speed, S_{FR}	45.0		

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	1995	0.90	Level	7	0	0.966	1.00	2294
Ramp	605	0.90	Level	4	0	0.980	1.00	686
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 1.000 using Equation (Exhibit 13-7)

V_{12} = 2294 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	2294	Exhibit 13-8	4500	No
$V_{FO} = V_F - V_R$	1608	Exhibit 13-8	4500	No
V_R	686	Exhibit 13-10	2100	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	2294	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = 20.8 (pc/mi/ln)

LOS = C (Exhibit 13-2)

Speed Determination

D_s = 0.360 (Exhibit 13-12)

S_R= 50.3 mph (Exhibit 13-12)

S_0= N/A mph (Exhibit 13-12)

S = 50.3 mph (Exhibit 13-13)

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RAMP ADD OR DROP LANE ANALYSIS (MAINLINE <55 MPH)

ATKINS

General Information

Date Performed:	7/25/2014	Freeway/Direction	Montague NB
Analysis Year	2018 No Action	Junction	From I-26 EB
Analysis Time Period:	AM Peak	Segment ID	8020
Project Description:	Navy Base ICTF		

Inputs

	Mainline Upstream Ramp	Mainline Downstream Ramp	Ramp
Number of Lanes, N	2	3	1
Free-Flow Speed, FFS (mph)	45	45	25
Volume, V (veh/h)	1,233	1,682	449
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	9%	7%	6%
%RVs, P_R	0%	0%	0%

Performance Measures

	Upstream of Off-Ramp	Downstream of Off-Ramp	Off-Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.96	0.97	0.97
Demand Flow Rate, v_p (pc/h/ln)	716	645	514
Capacity Flow Rate, c (pc/h/ln)	2,100	2,100	1,900
v/c ratio	0.34	0.31	0.27
Density, D_{MD} (pc/mi/ln)	12.5	11.3	9.0
LOS	B	B	A

Formulas and Reference Material

$$f_{HV} = \frac{1}{1+P_T(E_T-1)+P_R(E_R-1)}$$ HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P}$$ HCM 2010, Equation 11-2

$$D_{MD} = \frac{0.0175*v_f}{N}$$ HCM 2010, Equation 13-26

Ramp Roadways Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

Diverge LOS Thresholds

LOS	Density (pc/mi/ln)
A	≤10
B	>10-20
C	>20-28
D	>28-35
E	>35
F	v/c > 1

Source: HCM 2010, Exhibit 13-2

RAMP ADD OR DROP LANE ANALYSIS (MAINLINE <55 MPH)

ATKINS

General Information

Date Performed:	7/25/2014	Freeway/Direction	Montague NB
Analysis Year	2018 No Action	Junction	From I-26 EB
Analysis Time Period:	PM Peak	Segment ID	8020
Project Description:	Navy Base ICTF		

Inputs

	Mainline Upstream Ramp	Mainline Downstream Ramp	Ramp
Number of Lanes, N	2	3	1
Free-Flow Speed, FFS (mph)	45	45	25
Volume, V (veh/h)	1,390	1,637	247
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	7%	5%	9%
%RVs, P_R	0%	0%	0%

Performance Measures

	Upstream of Off-Ramp	Downstream of Off-Ramp	Off-Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.97	0.98	0.96
Demand Flow Rate, v_p (pc/h/ln)	799	621	287
Capacity Flow Rate, c (pc/h/ln)	2,100	2,100	1,900
v/c ratio	0.38	0.30	0.15
Density, D_{MD} (pc/mi/ln)	14.0	10.9	5.0
LOS	B	B	A

Formulas and Reference Material

$$f_{HV} = \frac{1}{1+P_T(E_T-1)+P_R(E_R-1)}$$ HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P}$$ HCM 2010, Equation 11-2

$$D_{MD} = \frac{0.0175*v_f}{N}$$ HCM 2010, Equation 13-26

Ramp Roadways Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

Diverge LOS Thresholds

LOS	Density (pc/mi/ln)
A	≤10
B	>10-20
C	>20-28
D	>28-35
E	>35
F	v/c > 1

Source: HCM 2010, Exhibit 13-2

RAMP ADD OR DROP LANE ANALYSIS (MAINLINE <55 MPH)

ATKINS

General Information

Date Performed:	7/25/2014	Freeway/Direction	Montague SB
Analysis Year	2018 No Action	Junction	Off to I-26 EB
Analysis Time Period:	AM Peak	Segment ID	8030
Project Description:	Navy Base ICTF		

Inputs

	Mainline Upstream Ramp	Mainline Downstream Ramp	Ramp
Number of Lanes, N	3	2	1
Free-Flow Speed, FFS (mph)	45	45	25
Volume, V (veh/h)	1,521	1,158	363
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	7%	9%	9%
%RVs, P_R	0%	0%	0%

Performance Measures

	Upstream of Off-Ramp	Downstream of Off-Ramp	Off-Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.97	0.96	0.96
Demand Flow Rate, v_p (pc/h/ln)	583	672	421
Capacity Flow Rate, c (pc/h/ln)	2,100	2,100	1,900
v/c ratio	0.28	0.32	0.22
Density, D_{MD} (pc/mi/ln)	10.2	11.8	7.4
LOS	B	B	A

Formulas and Reference Material

$$f_{HV} = \frac{1}{1+P_T(E_T-1)+P_R(E_R-1)}$$ HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P}$$ HCM 2010, Equation 11-2

$$D_{MD} = \frac{0.0175*v_f}{N}$$ HCM 2010, Equation 13-26

Ramp Roadways Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

Diverge LOS Thresholds

LOS	Density (pc/mi/ln)
A	≤10
B	>10-20
C	>20-28
D	>28-35
E	>35
F	v/c > 1

Source: HCM 2010, Exhibit 13-2

RAMP ADD OR DROP LANE ANALYSIS (MAINLINE <55 MPH)

ATKINS

General Information

Date Performed:	7/25/2014	Freeway/Direction	Montague SB
Analysis Year	2018 No Action	Junction	Off to I-26 EB
Analysis Time Period:	PM Peak	Segment ID	8030
Project Description:	Navy Base ICTF		

Inputs

	Mainline Upstream Ramp	Mainline Downstream Ramp	Ramp
Number of Lanes, N	3	2	1
Free-Flow Speed, FFS (mph)	45	45	25
Volume, V (veh/h)	1,861	1,412	449
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	5%	7%	6%
%RVs, P_R	0%	0%	0%

Performance Measures

	Upstream of Off-Ramp	Downstream of Off-Ramp	Off-Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.98	0.97	0.97
Demand Flow Rate, v_p (pc/h/ln)	706	812	514
Capacity Flow Rate, c (pc/h/ln)	2,100	2,100	1,900
v/c ratio	0.34	0.39	0.27
Density, D_{MD} (pc/mi/ln)	12.4	14.2	9.0
LOS	B	B	A

Formulas and Reference Material

$$f_{HV} = \frac{1}{1+P_T(E_T-1)+P_R(E_R-1)}$$ HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P}$$ HCM 2010, Equation 11-2

$$D_{MD} = \frac{0.0175*v_f}{N}$$ HCM 2010, Equation 13-26

Ramp Roadways Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

Diverge LOS Thresholds

LOS	Density (pc/mi/ln)
A	≤10
B	>10-20
C	>20-28
D	>28-35
E	>35
F	v/c > 1

Source: HCM 2010, Exhibit 13-2

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	Montague SB
Agency or Company	Atkins	Junction	8040 - On from I-26 EB
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2018 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Freeway Number of Lanes, N: 2	☐ Yes ☐ On
☑ No ☐ Off	Ramp Number of Lanes, N: 1	☑ No ☐ Off
L_{up} = ft	Acceleration Lane Length, L_A: 550	L_{down} = ft
V_u = veh/h	Deceleration Lane Length L_D:	V_D = veh/h
	Freeway Volume, V_F: 1158	
	Ramp Volume, V_R: 416	
	Freeway Free-Flow Speed, S_{FF}: 55.0	
	Ramp Free-Flow Speed, S_{FR}: 45.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	1158	0.90	Level	9	0	0.957	1.00	1345
Ramp	416	0.90	Level	14	0	0.935	1.00	495
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 1.000 using Equation (Exhibit 13-6)

V_{12} = 1345 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	1840	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	1840	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = 16.2 (pc/mi/ln)

LOS = B (Exhibit 13-2)

Speed Determination

M_S = 0.296 (Exibit 13-11)

S_R= 51.2 mph (Exhibit 13-11)

S_0= N/A mph (Exhibit 13-11)

S = 51.2 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	Montague SB
Agency or Company	Atkins	Junction	8040 - On from I-26 EB
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2018 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Freeway Number of Lanes, N: 2	☐ Yes ☐ On
☑ No ☐ Off	Ramp Number of Lanes, N: 1	☑ No ☐ Off
L_{up} = ft	Acceleration Lane Length, L_A: 550	L_{down} = ft
V_u = veh/h	Deceleration Lane Length L_D:	V_D = veh/h
	Freeway Volume, V_F: 1412	
	Ramp Volume, V_R: 241	
	Freeway Free-Flow Speed, S_{FF}: 55.0	
	Ramp Free-Flow Speed, S_{FR}: 45.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	1412	0.90	Level	7	0	0.966	1.00	1624
Ramp	241	0.90	Level	8	0	0.962	1.00	278
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 1.000 using Equation (Exhibit 13-6)

V_{12} = 1624 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	1902	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	1902	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = 16.7 (pc/mi/ln)

LOS = B (Exhibit 13-2)

Speed Determination

M_S = 0.298 (Exibit 13-11)

S_R= 51.1 mph (Exhibit 13-11)

S_0= N/A mph (Exhibit 13-11)

S = 51.1 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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RAMP ADD OR DROP LANE ANALYSIS (MAINLINE <55 MPH)

ATKINS

General Information

Date Performed:	7/25/2014	Freeway/Direction	PAR NB
Analysis Year	2018 No Action	Junction	Merge from 26 EB & WB
Analysis Time Period:	AM Peak	Segment ID	9010
Project Description:	Navy Base ICTF		

Inputs

	Mainline Upstream Ramp	Mainline Downstream Ramp	Ramp
Number of Lanes, N	1	2	1
Free-Flow Speed, FFS (mph)	55	55	55
Volume, V (veh/h)	91	210	119
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	2%	2%	2%
%RVs, P_R	0%	0%	0%

Performance Measures

	Upstream of Off-Ramp	Downstream of Off-Ramp	Off-Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.99	0.99	0.99
Demand Flow Rate, v_p (pc/h/ln)	102	118	134
Capacity Flow Rate, c (pc/h/ln)	2,200	2,200	2,200
v/c ratio	0.05	0.05	0.06
Density, D_{MD} (pc/mi/ln)	1.8	2.1	2.3
LOS	A	A	A

Formulas and Reference Material

$$f_{HV} = \frac{1}{1+P_T(E_T-1)+P_R(E_R-1)}$$ HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P}$$ HCM 2010, Equation 11-2

$$D_{MD} = \frac{0.0175*v_f}{N}$$ HCM 2010, Equation 13-26

Ramp Roadways Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

Diverge LOS Thresholds

LOS	Density (pc/mi/ln)
A	≤10
B	>10-20
C	>20-28
D	>28-35
E	>35
F	v/c > 1

Source: HCM 2010, Exhibit 13-2

RAMP ADD OR DROP LANE ANALYSIS (MAINLINE <55 MPH)

ATKINS

General Information

Date Performed:	7/25/2014	Freeway/Direction	PAR NB
Analysis Year	2018 No Action	Junction	Merge from 26 EB & WB
Analysis Time Period:	PM Peak	Segment ID	9010
Project Description:	Navy Base ICTF		

Inputs

	Mainline Upstream Ramp	Mainline Downstream Ramp	Ramp
Number of Lanes, N	1	2	1
Free-Flow Speed, FFS (mph)	55	55	55
Volume, V (veh/h)	37	115	78
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	2%	2%	2%
%RVs, P_R	0%	0%	0%

Performance Measures

	Upstream of Off-Ramp	Downstream of Off-Ramp	Off-Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.99	0.99	0.99
Demand Flow Rate, v_p (pc/h/ln)	42	65	88
Capacity Flow Rate, c (pc/h/ln)	2,200	2,200	2,200
v/c ratio	0.02	0.03	0.04
Density, D_{MD} (pc/mi/ln)	0.7	1.1	1.5
LOS	A	A	A

Formulas and Reference Material

$$f_{HV} = \frac{1}{1+P_T(E_T-1)+P_R(E_R-1)}$$ HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P}$$ HCM 2010, Equation 11-2

$$D_{MD} = \frac{0.0175*v_f}{N}$$ HCM 2010, Equation 13-26

Ramp Roadways Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

Diverge LOS Thresholds

LOS	Density (pc/mi/ln)
A	≤10
B	>10-20
C	>20-28
D	>28-35
E	>35
F	v/c > 1

Source: HCM 2010, Exhibit 13-2

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	PAR NB
Agency or Company	Atkins	Junction	9020 - Off to Local Access Rd
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2018 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Freeway Number of Lanes, N	2	Downstream Adj Ramp	
☐ Yes	☐ On	Ramp Number of Lanes, N	1	☐ Yes	☐ On
☑ No	☐ Off	Acceleration Lane Length, L_A		☑ No	☐ Off
L_{up} =	ft	Deceleration Lane Length L_D	950	L_{down} =	ft
V_u =	veh/h	Freeway Volume, V_F	210	V_D =	veh/h
		Ramp Volume, V_R	210		
		Freeway Free-Flow Speed, S_{FF}	55.0		
		Ramp Free-Flow Speed, S_{FR}	45.0		

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	210	0.90	Level	2	0	0.990	1.00	236
Ramp	210	0.90	Level	2	0	0.990	1.00	236
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 1.000 using Equation (Exhibit 13-7)

V_{12} = 236 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	236	Exhibit 13-8	4500	No
$V_{FO} = V_F - V_R$	0	Exhibit 13-8	4500	No
V_R	236	Exhibit 13-10	2100	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	236	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = -2.3 (pc/mi/ln)

LOS = A (Exhibit 13-2)

Speed Determination

D_s = 0.319 (Exhibit 13-12)

S_R= 50.8 mph (Exhibit 13-12)

S_0= N/A mph (Exhibit 13-12)

S = 50.8 mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	PAR NB
Agency or Company	Atkins	Junction	9020 - Off to Local Access Rd
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2018 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Freeway Number of Lanes, N: 2	☐ Yes ☐ On
☑ No ☐ Off	Ramp Number of Lanes, N: 1	☑ No ☐ Off
L_{up} = ft	Acceleration Lane Length, L_A	L_{down} = ft
V_u = veh/h	Deceleration Lane Length L_D: 950	V_D = veh/h
	Freeway Volume, V_F: 115	
	Ramp Volume, V_R: 115	
	Freeway Free-Flow Speed, S_{FF}: 55.0	
	Ramp Free-Flow Speed, S_{FR}: 45.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	115	0.90	Level	2	0	0.990	1.00	129
Ramp	115	0.90	Level	2	0	0.990	1.00	129
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 1.000 using Equation (Exhibit 13-7)

V_{12} = 129 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	129	Exhibit 13-8	4500	No
$V_{FO} = V_F - V_R$	0	Exhibit 13-8	4500	No
V_R	129	Exhibit 13-10	2100	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	129	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = -3.2 (pc/mi/ln)

LOS = A (Exhibit 13-2)

Speed Determination

D_s = 0.310 (Exhibit 13-12)

S_R= 51.0 mph (Exhibit 13-12)

S_0= N/A mph (Exhibit 13-12)

S = 51.0 mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	PAR SB
Agency or Company	Atkins	Junction	9030 - On from Local Access Rd
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2018 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Number of Lanes, N: 2	☐ Yes ☐ On
☑ No ☐ Off	Acceleration Lane Length, L_A: 1000	☑ No ☐ Off
L_{up} = ft	Deceleration Lane Length L_D:	L_{down} = ft
V_u = veh/h	Freeway Volume, V_F: 0	V_D = veh/h
	Ramp Volume, V_R: 106	
	Freeway Free-Flow Speed, S_{FF}: 55.0	
	Ramp Free-Flow Speed, S_{FR}: 45.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	0	0.90	Level	0	0	1.000	1.00	0
Ramp	106	0.90	Level	2	0	0.990	1.00	119
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 1.000 using Equation (Exhibit 13-6)

V_{12} = 0 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	119	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	119	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = 0.1 (pc/mi/ln)

LOS = A (Exhibit 13-2)

Speed Determination

M_S = 0.235 (Exibit 13-11)

S_R= 51.9 mph (Exhibit 13-11)

S_0= N/A mph (Exhibit 13-11)

S = 51.9 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	PAR SB
Agency or Company	Atkins	Junction	9030 - On from Local Access Rd
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2018 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Number of Lanes, N: 2	☐ Yes ☐ On
☑ No ☐ Off	Acceleration Lane Length, L_A: 1000	☑ No ☐ Off
L_{up} = ft	Deceleration Lane Length L_D:	L_{down} = ft
V_u = veh/h	Freeway Volume, V_F: 0	V_D = veh/h
	Ramp Volume, V_R: 209	
	Freeway Free-Flow Speed, S_{FF}: 55.0	
	Ramp Free-Flow Speed, S_{FR}: 45.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	0	0.90	Level	0	0	1.000	1.00	0
Ramp	209	0.90	Level	2	0	0.990	1.00	235
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 1.000 using Equation (Exhibit 13-6)

V_{12} = 0 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	235	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	235	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = 0.9 (pc/mi/ln)

LOS = A (Exhibit 13-2)

Speed Determination

M_S = 0.236 (Exibit 13-11)

S_R= 51.9 mph (Exhibit 13-11)

S_0= N/A mph (Exhibit 13-11)

S = 51.9 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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RAMP ADD OR DROP LANE ANALYSIS (MAINLINE <55 MPH)

ATKINS

General Information

Date Performed:	7/25/2014	Freeway/Direction	PAR SB
Analysis Year	2018 No Action	Junction	Split to 26 EB & WB
Analysis Time Period:	AM Peak	Segment ID	9040
Project Description:	Navy Base ICTF		

Inputs

	Mainline Upstream Ramp	Mainline Downstream Ramp	Ramp
Number of Lanes, N	2	1	1
Free-Flow Speed, FFS (mph)	55	55	55
Volume, V (veh/h)	106	75	31
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	2%	2%	2%
%RVs, P_R	0%	0%	0%

Performance Measures

	Upstream of Off-Ramp	Downstream of Off-Ramp	Off-Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.99	0.99	0.99
Demand Flow Rate, v_p (pc/h/ln)	59	84	35
Capacity Flow Rate, c (pc/h/ln)	2,200	2,200	2,200
v/c ratio	0.03	0.04	0.02
Density, D_{MD} (pc/mi/ln)	1.0	1.5	0.6
LOS	A	A	A

Formulas and Reference Material

$$f_{HV} = \frac{1}{1+P_T(E_T-1)+P_R(E_R-1)}$$ HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P}$$ HCM 2010, Equation 11-2

$$D_{MD} = \frac{0.0175*v_f}{N}$$ HCM 2010, Equation 13-26

Ramp Roadways Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

Diverge LOS Thresholds

LOS	Density (pc/mi/ln)
A	≤10
B	>10-20
C	>20-28
D	>28-35
E	>35
F	v/c > 1

Source: HCM 2010, Exhibit 13-2

RAMP ADD OR DROP LANE ANALYSIS (MAINLINE <55 MPH)

ATKINS

General Information

Date Performed:	7/25/2014	Freeway/Direction	PAR SB
Analysis Year	2018 No Action	Junction	Split to 26 EB & WB
Analysis Time Period:	PM Peak	Segment ID	9040
Project Description:	Navy Base ICTF		

Inputs

	Mainline Upstream Ramp	Mainline Downstream Ramp	Ramp
Number of Lanes, N	2	1	1
Free-Flow Speed, FFS (mph)	55	55	55
Volume, V (veh/h)	209	134	75
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	2%	2%	2%
%RVs, P_R	0%	0%	0%

Performance Measures

	Upstream of Off-Ramp	Downstream of Off-Ramp	Off-Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.99	0.99	0.99
Demand Flow Rate, v_p (pc/h/ln)	117	150	84
Capacity Flow Rate, c (pc/h/ln)	2,200	2,200	2,200
v/c ratio	0.05	0.07	0.04
Density, D_{MD} (pc/mi/ln)	2.0	2.6	1.5
LOS	A	A	A

Formulas and Reference Material

$$f_{HV} = \frac{1}{1+P_T(E_T-1)+P_R(E_R-1)}$$ HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P}$$ HCM 2010, Equation 11-2

$$D_{MD} = \frac{0.0175*v_f}{N}$$ HCM 2010, Equation 13-26

Ramp Roadways Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

Diverge LOS Thresholds

LOS	Density (pc/mi/ln)
A	≤10
B	>10-20
C	>20-28
D	>28-35
E	>35
F	v/c > 1

Source: HCM 2010, Exhibit 13-2

Arterial Level of Service: NB #1

Cross Street	Arterial Class	Flow Speed	Running Time	Signal Delay	Travel Time (s)	Dist (mi)	Arterial Speed	Arterial LOS
Viaduct Rd	II	40	28.5	13.2	41.7	0.26	22.3	C
Carolina Ave	II	35	43.3	3.6	46.9	0.41	31.7	B
Reynolds Ave	II	35	44.7	9.5	54.2	0.43	28.5	B
Cosgrove Ave	II	40	29.3	14.0	43.3	0.29	23.9	C
McMillan Ave	II	40	16.8	17.2	34.0	0.15	15.5	E
Total	II		162.6	57.5	220.1	1.53	25.1	C

Arterial Level of Service: SB #1

Cross Street	Arterial Class	Flow Speed	Running Time	Signal Delay	Travel Time (s)	Dist (mi)	Arterial Speed	Arterial LOS
Cosgrove Ave	II	40	16.8	20.4	37.2	0.15	14.1	E
Reynolds Ave	II	40	29.3	17.0	46.3	0.29	22.3	C
Carolina Ave	II	35	44.7	4.7	49.4	0.43	31.3	B
Burton Ln	II	40	39.6	13.8	53.4	0.41	27.8	C
Stromboli Ave	II	40	28.5	6.7	35.2	0.26	26.5	C
Total	II		158.9	62.6	221.5	1.53	24.9	C

Arterial Level of Service: NB #1

Cross Street	Arterial Class	Flow Speed	Running Time	Signal Delay	Travel Time (s)	Dist (mi)	Arterial Speed	Arterial LOS
Viaduct Rd	II	40	28.5	18.5	47.0	0.26	19.8	D
Carolina Ave	II	35	43.3	4.9	48.2	0.41	30.8	B
Reynolds Ave	II	35	44.7	15.6	60.3	0.43	25.6	C
Cosgrove Ave	II	40	29.3	25.1	54.4	0.29	19.0	D
McMillan Ave	II	40	16.8	22.7	39.5	0.15	13.3	E
Total	II		162.6	86.8	249.4	1.53	22.1	C

Arterial Level of Service: SB #1

Cross Street	Arterial Class	Flow Speed	Running Time	Signal Delay	Travel Time (s)	Dist (mi)	Arterial Speed	Arterial LOS
Cosgrove Ave	II	40	16.8	15.2	32.0	0.15	16.4	E
Reynolds Ave	II	40	29.3	9.9	39.2	0.29	26.4	C
Carolina Ave	II	35	44.7	3.6	48.3	0.43	32.0	B
Burton Ln	II	40	39.6	13.2	52.8	0.41	28.1	B
Stromboli Ave	II	40	28.5	10.0	38.5	0.26	24.2	C
Total	II		158.9	51.9	210.8	1.53	26.2	C

Arterial Level of Service: NB #2

Cross Street	Arterial Class	Flow Speed	Running Time	Signal Delay	Travel Time (s)	Dist (mi)	Arterial Speed	Arterial LOS
Burton Ln	III	34	35.4	10.4	45.8	0.29	23.2	C
Reynolds Ave	III	35	50.6	9.2	59.8	0.42	25.4	B
Cosgrove Ave	III	35	27.9	18.3	46.2	0.23	18.1	C
Dorchester Rd	III	35	18.7	3.4	22.1	0.15	23.8	C
McMillan Ave	III	35	24.5	15.7	40.2	0.20	18.3	C
Total	III		157.1	57.0	214.1	1.30	21.8	C

Arterial Level of Service: SB #2

Cross Street	Arterial Class	Flow Speed	Running Time	Signal Delay	Travel Time (s)	Dist (mi)	Arterial Speed	Arterial LOS
Dorchester Rd	II	35	25.5	5.5	31.0	0.20	23.7	C
Cosgrove Ave	II	35	18.3	25.5	43.8	0.15	12.0	F
Reynolds Ave	II	35	27.6	3.1	30.7	0.23	27.2	C
Burton Ln	II	35	44.6	11.6	56.2	0.43	27.5	C
Stromboli Ave	II	37	32.4	2.0	34.4	0.29	30.8	B
Total	II		148.4	47.7	196.1	1.31	24.0	C

Arterial Level of Service: NB #2

Cross Street	Arterial Class	Flow Speed	Running Time	Signal Delay	Travel Time (s)	Dist (mi)	Arterial Speed	Arterial LOS
Burton Ln	III	34	35.4	11.4	46.8	0.29	22.7	C
Reynolds Ave	III	35	50.6	13.0	63.6	0.42	23.9	C
Cosgrove Ave	III	35	27.9	29.7	57.6	0.23	14.5	D
Dorchester Rd	III	35	18.7	3.1	21.8	0.15	24.1	B
McMillan Ave	III	35	24.5	18.8	43.3	0.20	17.0	D
Total	III		157.1	76.0	233.1	1.30	20.1	C

Arterial Level of Service: SB #2

Cross Street	Arterial Class	Flow Speed	Running Time	Signal Delay	Travel Time (s)	Dist (mi)	Arterial Speed	Arterial LOS
Dorchester Rd	II	35	25.5	5.1	30.6	0.20	24.0	C
Cosgrove Ave	II	35	18.3	43.7	62.0	0.15	8.5	F
Reynolds Ave	II	35	27.6	3.0	30.6	0.23	27.3	C
Burton Ln	II	35	44.6	11.3	55.9	0.43	27.6	C
Stromboli Ave	II	37	32.4	3.6	36.0	0.29	29.5	B
Total	II		148.4	66.7	215.1	1.31	21.9	D

Appendix E
Traffic Analysis Worksheets

2038 Design Year

No Action Alternative

Appendix E
Traffic Analysis Worksheets

2038 Design Year

No Action Alternative

Interstate 26

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-26 EB
Agency or Company	Atkins	Junction	1010-EB Off to C-D
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2038 No-Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Number of Lanes, N	4	Downstream Adj Ramp	
☐ Yes	☐ On	Acceleration Lane Length, L_A		☐ Yes	☐ On
☑ No	☐ Off	Deceleration Lane Length L_D	400	☑ No	☐ Off
L_{up} =	ft	Freeway Volume, V_F	9132	L_{down} =	ft
V_u =	veh/h	Ramp Volume, V_R	1080	V_D =	veh/h
		Freeway Free-Flow Speed, S_{FF}	60.0		
		Ramp Free-Flow Speed, S_{FR}	55.0		

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	9132	0.90	Level	15	0	0.930	1.00	10908
Ramp	1080	0.90	Level	5	0	0.976	1.00	1230
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 0.436 using Equation (Exhibit 13-7)

V_{12} = 5450 pc/h

V_3 or V_{av34} 2729 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☑ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = 5508 pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	10908	Exhibit 13-8	9200	Yes
$V_{FO} = V_F - V_R$	9678	Exhibit 13-8	9200	Yes
V_R	1230	Exhibit 13-10	2200	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	5450	Exhibit 13-8	4400:All	Yes

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = 48.0 (pc/mi/ln)

LOS = F (Exhibit 13-2)

Speed Determination

D_s = 0.279 (Exhibit 13-12)

S_R= 55.0 mph (Exhibit 13-12)

S_0= 59.2 mph (Exhibit 13-12)

S = 57.0 mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-26 EB
Agency or Company	Atkins	Junction	1010-EB Off to C-D
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2038 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Number of Lanes, N: 4	☐ Yes ☐ On
☑ No ☐ Off	Acceleration Lane Length, L_A:	☑ No ☐ Off
L_{up} = ft	Deceleration Lane Length L_D: 400	L_{down} = ft
V_u = veh/h	Freeway Volume, V_F: 5893	V_D = veh/h
	Ramp Volume, V_R: 592	
	Freeway Free-Flow Speed, S_{FF}: 60.0	
	Ramp Free-Flow Speed, S_{FR}: 55.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	5893	0.90	Level	12	0	0.943	1.00	6941
Ramp	592	0.90	Level	8	0	0.962	1.00	684
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 0.436 using Equation (Exhibit 13-7)

V_{12} = 3412 pc/h

V_3 or V_{av34} 1764 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	6941	Exhibit 13-8	9200	No
$V_{FO} = V_F - V_R$	6257	Exhibit 13-8	9200	No
V_R	684	Exhibit 13-10	2200	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	3412	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = 30.0 (pc/mi/ln)

LOS = D (Exhibit 13-2)

Speed Determination

D_s = 0.230 (Exhibit 13-12)

S_R= 55.9 mph (Exhibit 13-12)

S_0= 62.8 mph (Exhibit 13-12)

S = 59.2 mph (Exhibit 13-13)

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-26 EB*
Agency or Company	*Atkins*	From/To	*1015-Avai/Rem CD Off to CD On*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2038 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*8052*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*16*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.926*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*4*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*60.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*60.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*2416*	pc/h/ln
S	*47.9*	mph
D = v_p / S	*50.4*	pc/mi/ln
LOS	*F*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-26 EB*
Agency or Company	*Atkins*	From/To	*1015-Avai/Rem CD Off to CD On*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*PM Peak*	Analysis Year	*2038 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*5301*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*13*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.939*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*4*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*60.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*60.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1568*	pc/h/ln
S	*60.0*	mph
D = v_p / S	*26.1*	pc/mi/ln
LOS	*D*	

Design (N)

Design (N)

Design LOS	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h/ln
S	mph
D = v_p / S	pc/mi/ln
Required Number of Lanes, N	

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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RAMP ADD OR DROP LANE ANALYSIS (MAINLINE <55 MPH)

ATKINS

General Information

Date Performed:	7/25/2014	Freeway/Direction	I-26 EB C-D
Analysis Year	2038 No Action	Junction	EB Off to Aviation Ave
Analysis Time Period:	AM Peak	Segment ID	1020
Project Description:	Navy Base ICTF		

Inputs

	Mainline Upstream Ramp	Mainline Downstream Ramp	Ramp
Number of Lanes, N	1	1	1
Free-Flow Speed, FFS (mph)	55	55	45
Volume, V (veh/h)	1,080	579	501
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	5%	5%	5%
%RVs, P_R	0%	0%	0%

Performance Measures

	Upstream of Off-Ramp	Downstream of Off-Ramp	Off-Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.98	0.98	0.98
Demand Flow Rate, v_p (pc/h/ln)	1,230	659	571
Capacity Flow Rate, c (pc/h/ln)	2,200	2,200	2,100
v/c ratio	0.56	0.30	0.27
Density, D_{MD} (pc/mi/ln)	21.5	11.5	10.0
LOS	C	B	A

Formulas and Reference Material

$$f_{HV} = \frac{1}{1+P_T(E_T-1)+P_R(E_R-1)}$$ HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P}$$ HCM 2010, Equation 11-2

$$D_{MD} = \frac{0.0175*v_f}{N}$$ HCM 2010, Equation 13-26

Ramp Roadways Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

Diverge LOS Thresholds

LOS	Density (pc/mi/ln)
A	≤10
B	>10-20
C	>20-28
D	>28-35
E	>35
F	v/c > 1

Source: HCM 2010, Exhibit 13-2

RAMP ADD OR DROP LANE ANALYSIS (MAINLINE <55 MPH)

ATKINS

General Information

Date Performed:	7/25/2014	Freeway/Direction	I-26 EB C-D
Analysis Year	2038 No-Action	Junction	EB Off to Aviation Ave
Analysis Time Period:	PM Peak	Segment ID	1020
Project Description:	Navy Base ICTF		

Inputs

	Mainline Upstream Ramp	Mainline Downstream Ramp	Ramp
Number of Lanes, N	1	1	1
Free-Flow Speed, FFS (mph)	55	55	45
Volume, V (veh/h)	592	379	213
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	8%	6%	10%
%RVs, P_R	0%	0%	0%

Performance Measures

	Upstream of Off-Ramp	Downstream of Off-Ramp	Off-Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.96	0.97	0.95
Demand Flow Rate, v_p (pc/h/ln)	684	434	249
Capacity Flow Rate, c (pc/h/ln)	2,200	2,200	2,100
v/c ratio	0.31	0.20	0.12
Density, D_{MD} (pc/mi/ln)	12.0	7.6	4.4
LOS	B	A	A

Formulas and Reference Material

$$f_{HV} = \frac{1}{1+P_T(E_T-1)+P_R(E_R-1)}$$ HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P}$$ HCM 2010, Equation 11-2

$$D_{MD} = \frac{0.0175*v_f}{N}$$ HCM 2010, Equation 13-26

Ramp Roadways Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

Diverge LOS Thresholds

LOS	Density (pc/mi/ln)
A	≤10
B	>10-20
C	>20-28
D	>28-35
E	>35
F	v/c > 1

Source: HCM 2010, Exhibit 13-2

BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-26 EB C-D*
Agency or Company	*Atkins*	From/To	*1025 - Avia Off to Avia WB On*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2038 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*1158*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*5*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.976*

Speed Inputs			Calc Speed Adj and FFS		
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f_{LW}		mph
Number of Lanes, N	*2*		f_{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	*55.0*	mph	FFS	*55.0*	mph
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures			Design (N)	
Operational (LOS)			Design (N)	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*659*	pc/h/ln	Design LOS	
			v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h/ln
S	*55.0*	mph	S	mph
D = v_p / S	*12.0*	pc/mi/ln	D = v_p / S	pc/mi/ln
LOS	*B*		Required Number of Lanes, N	

Glossary		Factor Location	
N - Number of lanes	S - Speed	E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
V - Hourly volume	D - Density	E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 11-18	TRD - Page 11-11
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 11-2, 11-3	
DDHV - Directional design hour volume			

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-26 EB C-D*
Agency or Company	*Atkins*	From/To	*1025 - Avia Off to Avia WB On*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*PM Peak*	Analysis Year	*2038 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*758*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*6*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.971*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*55.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*55.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*434*	pc/h/ln
S	*55.0*	mph
D = v_p / S	*7.9*	pc/mi/ln
LOS	*A*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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RAMP ADD OR DROP LANE ANALYSIS (MAINLINE <55 MPH)

ATKINS

General Information

Date Performed:	7/25/2014	Freeway/Direction	I-26 EB C-D
Analysis Year	2038 No Action	Junction	WB Aviation EB On Loop
Analysis Time Period:	AM Peak	Segment ID	1030
Project Description:	Navy Base ICTF		

Inputs

	Mainline Upstream Ramp	Mainline Downstream Ramp	Ramp
Number of Lanes, N	1	1	1
Free-Flow Speed, FFS (mph)	55	55	25
Volume, V (veh/h)	579	875	296
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	5%	4%	3%
%RVs, P_R	0%	0%	0%

Performance Measures

	Upstream of Off-Ramp	Downstream of Off-Ramp	Off-Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.98	0.98	0.99
Demand Flow Rate, v_p (pc/h/ln)	659	992	334
Capacity Flow Rate, c (pc/h/ln)	2,200	2,200	1,900
v/c ratio	0.30	0.45	0.18
Density, D_{MD} (pc/mi/ln)	11.5	17.4	5.8
LOS	B	B	A

Formulas and Reference Material

$$f_{HV} = \frac{1}{1+P_T(E_T-1)+P_R(E_R-1)}$$ HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P}$$ HCM 2010, Equation 11-2

$$D_{MD} = \frac{0.0175*v_f}{N}$$ HCM 2010, Equation 13-26

Ramp Roadways Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

Diverge LOS Thresholds

LOS	Density (pc/mi/ln)
A	≤10
B	>10-20
C	>20-28
D	>28-35
E	>35
F	v/c > 1

Source: HCM 2010, Exhibit 13-2

RAMP ADD OR DROP LANE ANALYSIS (MAINLINE <55 MPH)

ATKINS

General Information

Date Performed:	7/25/2014	Freeway/Direction	I-26 EB C-D
Analysis Year	2038 No Action	Junction	WB Aviation EB On Loop
Analysis Time Period:	PM Peak	Segment ID	1030
Project Description:	Navy Base ICTF		

Inputs

	Mainline Upstream Ramp	Mainline Downstream Ramp	Ramp
Number of Lanes, N	1	1	1
Free-Flow Speed, FFS (mph)	55	55	25
Volume, V (veh/h)	379	850	471
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	6%	4%	2%
%RVs, P_R	0%	0%	0%

Performance Measures

	Upstream of Off-Ramp	Downstream of Off-Ramp	Off-Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.97	0.98	0.99
Demand Flow Rate, v_p (pc/h/ln)	434	963	529
Capacity Flow Rate, c (pc/h/ln)	2,200	2,200	1,900
v/c ratio	0.20	0.44	0.28
Density, D_{MD} (pc/mi/ln)	7.6	16.9	9.3
LOS	A	B	A

Formulas and Reference Material

$$f_{HV} = \frac{1}{1+P_T(E_T-1)+P_R(E_R-1)}$$ HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P}$$ HCM 2010, Equation 11-2

$$D_{MD} = \frac{0.0175*v_f}{N}$$ HCM 2010, Equation 13-26

Ramp Roadways Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

Diverge LOS Thresholds

LOS	Density (pc/mi/ln)
A	≤10
B	>10-20
C	>20-28
D	>28-35
E	>35
F	v/c > 1

Source: HCM 2010, Exhibit 13-2

Navy Base ICTF

FREEWAY WEAVING WORKSHEET

General Information

Analyst	AJR
Agency/Company	Atkins
Date Performed	7/25/2014
Analysis Time Period	AM Peak

Site Information

Freeway/Dir of Travel	I-26 EB - Aviation-Remount C-D
Weaving Segment Location	1040-EB Aviation to Remount
Analysis Year	2038 No Action

Project Description *Navy Base ICTF*

Inputs

Weaving configuration	One-Sided
Weaving number of lanes, N	2
Weaving segment length, L_S	535ft
Freeway free-flow speed, FFS	55 mph
Segment type	C-D Roadway/ Multilane Highways
Freeway minimum speed, S_{MIN}	15
Freeway maximum capacity, C_{IFL}	2250
Terrain type	Level

Conversions to pc/h Under Base Conditions

	V (veh/h)	PHF	Truck (%)	RV (%)	E_T	E_R	f_{HV}	f_p	v (pc/h)
V_{FF}	296	0.90	3	0	1.5	1.2	0.985	1.00	334
V_{RF}	308	0.90	11	0	1.5	1.2	0.948	1.00	361
V_{FR}	579	0.90	5	0	1.5	1.2	0.976	1.00	659
V_{RR}	0	0.90	0	0	1.5	1.2	1.000	1.00	0
V_{NW}	334							V =	1354
V_W	1020								
VR	0.753								

Configuration Characteristics

Minimum maneuver lanes, N_{WL}	2 lc	Minimum weaving lane changes, LC_{MIN}	1020 lc/h
Interchange density, ID	0.8 int/mi	Weaving lane changes, LC_W	1058 lc/h
Minimum RF lane changes, LC_{RF}	1 lc/pc	Non-weaving lane changes, LC_{NW}	0 lc/h
Minimum FR lane changes, LC_{FR}	1 lc/pc	Total lane changes, LC_{ALL}	1058 lc/h
Minimum RR lane changes, LC_{RR}	lc/pc	Non-weaving vehicle index, I_{NW}	14

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment flow rate, v	1354 pc/h	Weaving intensity factor, W	0.387
Weaving segment capacity, c_w	2865 veh/h	Weaving segment speed, S	44.0 mph
Weaving segment v/c ratio	0.466	Average weaving speed, S_W	43.8 mph
Weaving segment density, D	15.4 pc/mi/ln	Average non-weaving speed, S_{NW}	44.4 mph
Level of Service, LOS	B	Maximum weaving length, L_{MAX}	10934 ft

Notes

a. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments".
b. For volumes that exceed the weaving segment capacity, the level of service is "F".

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Navy Base ICTF

FREEWAY WEAVING WORKSHEET

General Information

Analyst	AJR
Agency/Company	Atkins
Date Performed	7/25//2014
Analysis Time Period	PM Peak

Site Information

Freeway/Dir of Travel	I-26 EB - Aviation-Remount C-D
Weaving Segment Location	1040-EB Aviation to Remount
Analysis Year	2038 No-Action

Project Description *Navy Base ICTF*

Inputs

Weaving configuration	One-Sided
Weaving number of lanes, N	2
Weaving segment length, L_S	535ft
Freeway free-flow speed, FFS	55 mph
Segment type	C-D Roadway/ Multilane Highways
Freeway minimum speed, S_{MIN}	15
Freeway maximum capacity, C_{IFL}	2250
Terrain type	Level

Conversions to pc/h Under Base Conditions

	V (veh/h)	PHF	Truck (%)	RV (%)	E_T	E_R	f_{HV}	f_p	v (pc/h)
V_{FF}	471	0.90	2	0	1.5	1.2	0.990	1.00	529
V_{RF}	548	0.90	5	0	1.5	1.2	0.976	1.00	624
V_{FR}	379	0.90	6	0	1.5	1.2	0.971	1.00	434
V_{RR}	0	0.90	0	0	1.5	1.2	1.000	1.00	0
V_{NW}	529							V =	1587
V_W	1058								
VR	0.667								

Configuration Characteristics

Minimum maneuver lanes, N_{WL}	2 lc	Minimum weaving lane changes, LC_{MIN}	1058 lc/h
Interchange density, ID	0.8 int/mi	Weaving lane changes, LC_W	1096 lc/h
Minimum RF lane changes, LC_{RF}	1 lc/pc	Non-weaving lane changes, LC_{NW}	14 lc/h
Minimum FR lane changes, LC_{FR}	1 lc/pc	Total lane changes, LC_{ALL}	1110 lc/h
Minimum RR lane changes, LC_{RR}	lc/pc	Non-weaving vehicle index, I_{NW}	23

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment flow rate, v	1587 pc/h	Weaving intensity factor, W	0.402
Weaving segment capacity, c_w	3046 veh/h	Weaving segment speed, S	43.5 mph
Weaving segment v/c ratio	0.516	Average weaving speed, S_W	43.5 mph
Weaving segment density, D	18.2 pc/mi/ln	Average non-weaving speed, S_{NW}	43.6 mph
Level of Service, LOS	B	Maximum weaving length, L_{MAX}	9839 ft

Notes

a. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments".
b. For volumes that exceed the weaving segment capacity, the level of service is "F".

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-26 EB C-D*
Agency or Company	*Atkins*	From/To	*1045-Remount Off to Remount On*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2038 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*1208*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*7*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.966*

Speed Inputs			Calc Speed Adj and FFS		
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f_{LW}		mph
Number of Lanes, N	*2*		f_{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	*55.0*	mph	FFS	*55.0*	mph
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures			Design (N)	
Operational (LOS)			Design (N)	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*695*	pc/h/ln	Design LOS	
			v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h/ln
S	*55.0*	mph	S	mph
D = v_p / S	*12.6*	pc/mi/ln	D = v_p / S	pc/mi/ln
LOS	*B*		Required Number of Lanes, N	

Glossary		Factor Location	
N - Number of lanes	S - Speed	E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
V - Hourly volume	D - Density	E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 11-18	TRD - Page 11-11
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 11-2, 11-3	
DDHV - Directional design hour volume			

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-26 EB C-D*
Agency or Company	*Atkins*	From/To	*1045-Remount Off to Remount On*
Date Performed	*4/25/2014*	Jurisdiction	
Analysis Time Period	*PM Peak*	Analysis Year	*2038 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*2038*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*3*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.985*

Speed Inputs			Calc Speed Adj and FFS		
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f_{LW}		mph
Number of Lanes, N	*2*		f_{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	*55.0*	mph	FFS	*55.0*	mph
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures			Design (N)	
Operational (LOS)			Design (N)	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1149*	pc/h/ln	Design LOS	
S	*55.0*	mph	v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h/ln
D = v_p / S	*20.9*	pc/mi/ln	S	mph
LOS	*C*		D = v_p / S	pc/mi/ln
			Required Number of Lanes, N	

Glossary		Factor Location	
N - Number of lanes	S - Speed	E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
V - Hourly volume	D - Density	E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 11-18	TRD - Page 11-11
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 11-2, 11-3	
DDHV - Directional design hour volume			

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RAMP ADD OR DROP LANE ANALYSIS (MAINLINE <55 MPH)

ATKINS

General Information

Date Performed:	7/25/2014	Freeway/Direction	I-26 EB C-D
Analysis Year	2038 No Action	Junction	Remount EB On Loop
Analysis Time Period:	AM Peak	Segment ID	1050
Project Description:	Navy Base ICTF		

Inputs

	Mainline Upstream Ramp	Mainline Downstream Ramp	Ramp
Number of Lanes, N	1	1	1
Free-Flow Speed, FFS (mph)	55	55	25
Volume, V (veh/h)	604	975	371
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	7%	5%	2%
%RVs, P_R	0%	0%	0%

Performance Measures

	Upstream of Off-Ramp	Downstream of Off-Ramp	Off-Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.97	0.98	0.99
Demand Flow Rate, v_p (pc/h/ln)	695	1,110	416
Capacity Flow Rate, c (pc/h/ln)	2,200	2,200	1,900
v/c ratio	0.32	0.50	0.22
Density, D_{MD} (pc/mi/ln)	12.2	19.4	7.3
LOS	B	B	A

Formulas and Reference Material

$$f_{HV} = \frac{1}{1+P_T(E_T-1)+P_R(E_R-1)}$$ HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P}$$ HCM 2010, Equation 11-2

$$D_{MD} = \frac{0.0175*v_f}{N}$$ HCM 2010, Equation 13-26

Ramp Roadways Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

Diverge LOS Thresholds

LOS	Density (pc/mi/ln)
A	≤10
B	>10-20
C	>20-28
D	>28-35
E	>35
F	v/c > 1

Source: HCM 2010, Exhibit 13-2

RAMP ADD OR DROP LANE ANALYSIS (MAINLINE <55 MPH)

ATKINS

General Information

Date Performed:	3/20/2014	Freeway/Direction	I-26 EB C-D
Analysis Year	2038 No Action	Junction	Remount EB On Loop
Analysis Time Period:	PM Peak	Segment ID	1050
Project Description:	Navy Base ICTF		

Inputs

	Mainline Upstream Ramp	Mainline Downstream Ramp	Ramp
Number of Lanes, N	1	1	1
Free-Flow Speed, FFS (mph)	55	55	25
Volume, V (veh/h)	1,019	1,446	427
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	3%	3%	2%
%RVs, P_R	0%	0%	0%

Performance Measures

	Upstream of Off-Ramp	Downstream of Off-Ramp	Off-Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.99	0.99	0.99
Demand Flow Rate, v_p (pc/h/ln)	1,149	1,631	479
Capacity Flow Rate, c (pc/h/ln)	2,200	2,200	1,900
v/c ratio	0.52	0.74	0.25
Density, D_{MD} (pc/mi/ln)	20.1	28.5	8.4
LOS	C	D	A

Formulas and Reference Material

$$f_{HV} = \frac{1}{1+P_T(E_T-1)+P_R(E_R-1)}$$ HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P}$$ HCM 2010, Equation 11-2

$$D_{MD} = \frac{0.0175*v_f}{N}$$ HCM 2010, Equation 13-26

Ramp Roadways Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

Diverge LOS Thresholds

LOS	Density (pc/mi/ln)
A	≤10
B	>10-20
C	>20-28
D	>28-35
E	>35
F	v/c > 1

Source: HCM 2010, Exhibit 13-2

Navy Base ICTF

FREEWAY WEAVING WORKSHEET

General Information

Analyst	AJR
Agency/Company	Atkins
Date Performed	7/25/2014
Analysis Time Period	AM Peak

Site Information

Freeway/Dir of Travel	I-26 EB
Weaving Segment Location	1060-Avi-Rem C-D to 526 C-D
Analysis Year	2038 No Action

Project Description *Navy Base ICTF*

Inputs

Weaving configuration	One-Sided	Segment type	Freeway
Weaving number of lanes, N	5	Freeway minimum speed, S_{MIN}	15
Weaving segment length, L_S	1850ft	Freeway maximum capacity, C_{IFL}	2300
Freeway free-flow speed, FFS	60 mph	Terrain type	Level

Conversions to pc/h Under Base Conditions

	V (veh/h)	PHF	Truck (%)	RV (%)	E_T	E_R	f_{HV}	f_p	v (pc/h)
V_{FF}	4487	0.90	14	0	1.5	1.2	0.935	1.00	5335
V_{RF}	543	0.90	14	0	1.5	1.2	0.935	1.00	646
V_{FR}	3565	0.90	29	0	1.5	1.2	0.873	1.00	4535
V_{RR}	432	0.90	29	0	1.5	1.2	0.873	1.00	550
V_{NW}	5885							V =	11066
V_W	5181								
VR	0.468								

Configuration Characteristics

Minimum maneuver lanes, N_{WL}	2 lc	Minimum weaving lane changes, LC_{MIN}	lc/h
Interchange density, ID	0.7 int/mi	Weaving lane changes, LC_W	lc/h
Minimum RF lane changes, LC_{RF}	2 lc/pc	Non-weaving lane changes, LC_{NW}	lc/h
Minimum FR lane changes, LC_{FR}	0 lc/pc	Total lane changes, LC_{ALL}	lc/h
Minimum RR lane changes, LC_{RR}	lc/pc	Non-weaving vehicle index, I_{NW}	646

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment flow rate, v	11066 pc/h	Weaving intensity factor, W	
Weaving segment capacity, c_w	4791 veh/h	Weaving segment speed, S	mph
Weaving segment v/c ratio	2.159	Average weaving speed, S_W	mph
Weaving segment density, D	pc/mi/ln	Average non-weaving speed, S_{NW}	mph
Level of Service, LOS	F	Maximum weaving length, L_{MAX}	7457 ft

Notes

a. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments".
b. For volumes that exceed the weaving segment capacity, the level of service is "F".

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Navy Base ICTF

FREEWAY WEAVING WORKSHEET

General Information

Analyst	AJR
Agency/Company	Atkins
Date Performed	7/25/2014
Analysis Time Period	PM Peak

Site Information

Freeway/Dir of Travel	I-26 EB
Weaving Segment Location	1060-Avi-Rem C-D to 526 C-D
Analysis Year	2038 No Action

Project Description *Navy Base ICTF*

Inputs

Weaving configuration	One-Sided	Segment type	Freeway
Weaving number of lanes, N	5	Freeway minimum speed, S_{MIN}	15
Weaving segment length, L_S	1850ft	Freeway maximum capacity, C_{IFL}	2300
Freeway free-flow speed, FFS	60 mph	Terrain type	Level

Conversions to pc/h Under Base Conditions

	V (veh/h)	PHF	Truck (%)	RV (%)	E_T	E_R	f_{HV}	f_p	v (pc/h)
V_{FF}	2764	0.90	11	0	1.5	1.2	0.948	1.00	3240
V_{RF}	754	0.90	11	0	1.5	1.2	0.948	1.00	884
V_{FR}	2537	0.90	31	0	1.5	1.2	0.866	1.00	3256
V_{RR}	692	0.90	31	0	1.5	1.2	0.866	1.00	888
V_{NW}	4128							V =	8268
V_W	4140								
VR	0.501								

Configuration Characteristics

Minimum maneuver lanes, N_{WL}	2 lc	Minimum weaving lane changes, LC_{MIN}	lc/h
Interchange density, ID	0.7 int/mi	Weaving lane changes, LC_W	lc/h
Minimum RF lane changes, LC_{RF}	2 lc/pc	Non-weaving lane changes, LC_{NW}	lc/h
Minimum FR lane changes, LC_{FR}	0 lc/pc	Total lane changes, LC_{ALL}	lc/h
Minimum RR lane changes, LC_{RR}	lc/pc	Non-weaving vehicle index, I_{NW}	398

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment flow rate, v	8268 pc/h	Weaving intensity factor, W	
Weaving segment capacity, c_w	4543 veh/h	Weaving segment speed, S	mph
Weaving segment v/c ratio	1.725	Average weaving speed, S_W	mph
Weaving segment density, D	pc/mi/ln	Average non-weaving speed, S_{NW}	mph
Level of Service, LOS	F	Maximum weaving length, L_{MAX}	7835 ft

Notes

a. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments".
b. For volumes that exceed the weaving segment capacity, the level of service is "F".

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-26 EB*
Agency or Company	*Atkins*	From/To	*1065 - I-526 CD Off to CD On*
Date Performed	*4/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2038 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*5030*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*14*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.935*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*3*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*60.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*60.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1993*	pc/h/ln
S	*57.2*	mph
D = v_p / S	*34.8*	pc/mi/ln
LOS	*D*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-26 EB*
Agency or Company	*Atkins*	From/To	*1065 - I-526 CD Off to CD On*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*PM Peak*	Analysis Year	*2038 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*3518*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*11*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.948*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*3*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*60.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*60.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1375*	pc/h/ln
S	*60.0*	mph
D = v_p / S	*22.9*	pc/mi/ln
LOS	*C*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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RAMP ADD OR DROP LANE ANALYSIS (MAINLINE <55 MPH)

ATKINS

General Information

Date Performed:	7/25/2014	Freeway/Direction	I-26 EB C-D
Analysis Year	2038 No Action	Junction	EB Off to I-526 WB
Analysis Time Period:	AM Peak	Segment ID	1070
Project Description:	Navy Base ICTF		

Inputs

	Mainline Upstream Ramp	Mainline Downstream Ramp	Ramp
Number of Lanes, N	2	1	1
Free-Flow Speed, FFS (mph)	55	55	45
Volume, V (veh/h)	3,997	1,479	2,518
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	29%	51%	17%
%RVs, P_R	0%	0%	0%

Performance Measures

	Upstream of Off-Ramp	Downstream of Off-Ramp	Off-Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.87	0.80	0.92
Demand Flow Rate, v_p (pc/h/ln)	2,543	2,062	3,036
Capacity Flow Rate, c (pc/h/ln)	2,200	2,200	2,100
v/c ratio	1.16	0.94	1.45
Density, D_{MD} (pc/mi/ln)	44.5	36.1	53.1
LOS	F	E	F

Formulas and Reference Material

$$f_{HV} = \frac{1}{1+P_T(E_T-1)+P_R(E_R-1)}$$ HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P}$$ HCM 2010, Equation 11-2

$$D_{MD} = \frac{0.0175*v_f}{N}$$ HCM 2010, Equation 13-26

Ramp Roadways Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

Diverge LOS Thresholds

LOS	Density (pc/mi/ln)
A	≤10
B	>10-20
C	>20-28
D	>28-35
E	>35
F	v/c > 1

Source: HCM 2010, Exhibit 13-2

RAMP ADD OR DROP LANE ANALYSIS (MAINLINE <55 MPH)

ATKINS

General Information

Date Performed:	7/25/2014	Freeway/Direction	I-26 EB C-D
Analysis Year	2038 No Action	Junction	EB Off to I-526 WB
Analysis Time Period:	PM Peak	Segment ID	1070
Project Description:	Navy Base ICTF		

Inputs

	Mainline Upstream Ramp	Mainline Downstream Ramp	Ramp
Number of Lanes, N	2	1	1
Free-Flow Speed, FFS (mph)	55	55	45
Volume, V (veh/h)	3,229	1,210	2,019
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	31%	53%	18%
%RVs, P_R	0%	0%	0%

Performance Measures

	Upstream of Off-Ramp	Downstream of Off-Ramp	Off-Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.87	0.79	0.92
Demand Flow Rate, v_p (pc/h/ln)	2,072	1,701	2,445
Capacity Flow Rate, c (pc/h/ln)	2,200	2,200	2,100
v/c ratio	0.94	0.77	1.16
Density, D_{MD} (pc/mi/ln)	36.3	29.8	42.8
LOS	E	D	F

Formulas and Reference Material

$$f_{HV} = \frac{1}{1+P_T(E_T-1)+P_R(E_R-1)}$$ HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P}$$ HCM 2010, Equation 11-2

$$D_{MD} = \frac{0.0175*v_f}{N}$$ HCM 2010, Equation 13-26

Ramp Roadways Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

Diverge LOS Thresholds

LOS	Density (pc/mi/ln)
A	≤10
B	>10-20
C	>20-28
D	>28-35
E	>35
F	v/c > 1

Source: HCM 2010, Exhibit 13-2

BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-26 EB C-D*
Agency or Company	*Atkins*	From/To	*1075-I526 WB Off to I526 WB On*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2038 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*2958*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*51*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.797*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*55.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*55.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*2062*	pc/h/ln
S	*53.3*	mph
D = v_p / S	*38.7*	pc/mi/ln
LOS	*E*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-26 EB C-D*
Agency or Company	*Atkins*	From/To	*1075-I526 WB Off to I526 WB On*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*PM Peak*	Analysis Year	*2038 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*2420*	veh/h	Peak-Hour Factor, PHF	*0.90*	
AADT		veh/day	%Trucks and Buses, P_T	*53*	
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*	
Peak-Hr Direction Prop, D			General Terrain:	*Level*	
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*	

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.791*

Speed Inputs			Calc Speed Adj and FFS		
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f_{LW}		mph
Number of Lanes, N	*2*		f_{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	*55.0*	mph	FFS	*55.0*	mph
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures			Design (N)	
Operational (LOS)			Design (N)	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1701*	pc/h/ln	Design LOS	
			v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h/ln
S	*55.0*	mph	S	mph
D = v_p / S	*30.9*	pc/mi/ln	D = v_p / S	pc/mi/ln
LOS	*D*		Required Number of Lanes, N	

Glossary		Factor Location	
N - Number of lanes	S - Speed	E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
V - Hourly volume	D - Density	E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 11-18	TRD - Page 11-11
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 11-2, 11-3	
DDHV - Directional design hour volume			

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Navy Base ICTF

FREEWAY WEAVING WORKSHEET

General Information

Analyst	AJR
Agency/Company	Atkins
Date Performed	3/20/2014
Analysis Time Period	AM Peak

Site Information

Freeway/Dir of Travel	I-26 EB C-D
Weaving Segment Location	1080 - I-526 WB to I-526 EB
Analysis Year	2038 No Action

Project Description *Navy Base ICTF*

Inputs

Weaving configuration	One-Sided
Weaving number of lanes, N	2
Weaving segment length, L_S	620ft
Freeway free-flow speed, FFS	55 mph
Segment type	C-D Roadway/ Multilane Highways
Freeway minimum speed, S_{MIN}	15
Freeway maximum capacity, C_{IFL}	2250
Terrain type	Level

Conversions to pc/h Under Base Conditions

	V (veh/h)	PHF	Truck (%)	RV (%)	E_T	E_R	f_{HV}	f_p	v (pc/h)
V_{FF}	0	0.90	0	0	1.5	1.2	1.000	1.00	0
V_{RF}	566	0.90	8	0	1.5	1.2	0.962	1.00	654
V_{FR}	1479	0.90	51	0	1.5	1.2	0.797	1.00	2062
V_{RR}	0	0.90	0	0	1.5	1.2	1.000	1.00	0
V_{NW}	0							V =	2716
V_W	2716								
VR	1.000								

Configuration Characteristics

Minimum maneuver lanes, N_{WL}	2 lc	Minimum weaving lane changes, LC_{MIN}	lc/h
Interchange density, ID	0.8 int/mi	Weaving lane changes, LC_W	lc/h
Minimum RF lane changes, LC_{RF}	1 lc/pc	Non-weaving lane changes, LC_{NW}	lc/h
Minimum FR lane changes, LC_{FR}	1 lc/pc	Total lane changes, LC_{ALL}	lc/h
Minimum RR lane changes, LC_{RR}	lc/pc	Non-weaving vehicle index, I_{NW}	0

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment flow rate, v	2716 pc/h	Weaving intensity factor, W	
Weaving segment capacity, c_w	2400 veh/h	Weaving segment speed, S	mph
Weaving segment v/c ratio	1.132	Average weaving speed, S_W	mph
Weaving segment density, D	pc/mi/ln	Average non-weaving speed, S_{NW}	mph
Level of Service, LOS	F	Maximum weaving length, L_{MAX}	14232 ft

Notes

a. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments".
b. For volumes that exceed the weaving segment capacity, the level of service is "F".

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Navy Base ICTF

FREEWAY WEAVING WORKSHEET

General Information

Analyst	AJR
Agency/Company	Atkins
Date Performed	7/25/2014
Analysis Time Period	PM Peak

Site Information

Freeway/Dir of Travel	I-26 EB C-D
Weaving Segment Location	1080 - I-526 WB to I-526 EB
Analysis Year	2038 No Action

Project Description *Navy Base ICTF*

Inputs

Weaving configuration	One-Sided
Weaving number of lanes, N	2
Weaving segment length, L_S	620ft
Freeway free-flow speed, FFS	55 mph
Segment type	C-D Roadway/ Multilane Highways
Freeway minimum speed, S_{MIN}	15
Freeway maximum capacity, C_{IFL}	2250
Terrain type	Level

Conversions to pc/h Under Base Conditions

	V (veh/h)	PHF	Truck (%)	RV (%)	E_T	E_R	f_{HV}	f_p	v (pc/h)
V_{FF}	0	0.90	0	0	1.5	1.2	1.000	1.00	0
V_{RF}	498	0.90	7	0	1.5	1.2	0.966	1.00	573
V_{FR}	1210	0.90	53	0	1.5	1.2	0.791	1.00	1701
V_{RR}	0	0.90	0	0	1.5	1.2	1.000	1.00	0
V_{NW}	0							V =	2274
V_W	2274								
VR	1.000								

Configuration Characteristics

Minimum maneuver lanes, N_{WL}	2 lc	Minimum weaving lane changes, LC_{MIN}	2274 lc/h
Interchange density, ID	0.8 int/mi	Weaving lane changes, LC_W	2319 lc/h
Minimum RF lane changes, LC_{RF}	1 lc/pc	Non-weaving lane changes, LC_{NW}	0 lc/h
Minimum FR lane changes, LC_{FR}	1 lc/pc	Total lane changes, LC_{ALL}	2319 lc/h
Minimum RR lane changes, LC_{RR}	lc/pc	Non-weaving vehicle index, I_{NW}	0

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment flow rate, v	2274 pc/h	Weaving intensity factor, W	0.640
Weaving segment capacity, c_w	2400 veh/h	Weaving segment speed, S	39.4 mph
Weaving segment v/c ratio	0.947	Average weaving speed, S_W	39.4 mph
Weaving segment density, D	28.9 pc/mi/ln	Average non-weaving speed, S_{NW}	33.2 mph
Level of Service, LOS	C	Maximum weaving length, L_{MAX}	14232 ft

Notes

a. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments".
b. For volumes that exceed the weaving segment capacity, the level of service is "F".

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-26 EB C-D*
Agency or Company	*Atkins*	From/To	*1085-I526 EB Off to I526 EB On*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2038 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*1132*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*8*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.962*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*55.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*55.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*654*	pc/h/ln
S	*55.0*	mph
D = v_p / S	*11.9*	pc/mi/ln
LOS	*B*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-26 EB C-D*
Agency or Company	*Atkins*	From/To	*1085-I526 EB Off to I526 EB On*
Date Performed	*4/25/2014*	Jurisdiction	
Analysis Time Period	*PM Peak*	Analysis Year	*2038 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*996*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*7*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length	*mi*
			Up/Down %	

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.966*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*55.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*55.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*573*	pc/h/ln
S	*55.0*	mph
D = v_p / S	*10.4*	pc/mi/ln
LOS	*A*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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RAMP ADD OR DROP LANE ANALYSIS (MAINLINE <55 MPH)

ATKINS

General Information

Date Performed:	7/25/2014	Freeway/Direction	I-26 EB
Analysis Year	2038 No Action	Junction	I-526 EB Ramp Split
Analysis Time Period:	AM Peak	Segment ID	1088
Project Description:	Navy Base ICTF		

Inputs

	Mainline Upstream Ramp	Mainline Downstream Ramp	Ramp
Number of Lanes, N	2	2	1
Free-Flow Speed, FFS (mph)	55	55	55
Volume, V (veh/h)	2,467	2,168	299
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	9%	10%	3%
%RVs, P_R	0%	0%	0%

Performance Measures

	Upstream of Off-Ramp	Downstream of Off-Ramp	Off-Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.96	0.95	0.99
Demand Flow Rate, v_p (pc/h/ln)	1,432	1,265	337
Capacity Flow Rate, c (pc/h/ln)	2,200	2,200	2,200
v/c ratio	0.65	0.58	0.15
Density, D_{MD} (pc/mi/ln)	25.1	22.1	5.9
LOS	C	C	A

Formulas and Reference Material

$$f_{HV} = \frac{1}{1+P_T(E_T-1)+P_R(E_R-1)}$$ HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P}$$ HCM 2010, Equation 11-2

$$D_{MD} = \frac{0.0175*v_f}{N}$$ HCM 2010, Equation 13-26

Ramp Roadways Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

Diverge LOS Thresholds

LOS	Density (pc/mi/ln)
A	≤10
B	>10-20
C	>20-28
D	>28-35
E	>35
F	v/c > 1

Source: HCM 2010, Exhibit 13-2

RAMP ADD OR DROP LANE ANALYSIS (MAINLINE <55 MPH)

ATKINS

General Information

Date Performed:	3/20/2014	Freeway/Direction	I-26 EB
Analysis Year	2038 No Action	Junction	I-526 EB Ramp Split
Analysis Time Period:	PM Peak	Segment ID	1088
Project Description:	Navy Base ICTF		

Inputs

	Mainline Upstream Ramp	Mainline Downstream Ramp	Ramp
Number of Lanes, N	2	2	1
Free-Flow Speed, FFS (mph)	55	55	55
Volume, V (veh/h)	2,851	2,507	344
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	7%	7%	3%
%RVs, P_R	0%	0%	0%

Performance Measures

	Upstream of Off-Ramp	Downstream of Off-Ramp	Off-Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.97	0.97	0.99
Demand Flow Rate, v_p (pc/h/ln)	1,639	1,442	388
Capacity Flow Rate, c (pc/h/ln)	2,200	2,200	2,200
v/c ratio	0.75	0.66	0.18
Density, D_{MD} (pc/mi/ln)	28.7	25.2	6.8
LOS	D	C	A

Formulas and Reference Material

$$f_{HV} = \frac{1}{1+P_T(E_T-1)+P_R(E_R-1)}$$ HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P}$$ HCM 2010, Equation 11-2

$$D_{MD} = \frac{0.0175*v_f}{N}$$ HCM 2010, Equation 13-26

Ramp Roadways Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

Diverge LOS Thresholds

LOS	Density (pc/mi/ln)
A	≤10
B	>10-20
C	>20-28
D	>28-35
E	>35
F	v/c > 1

Source: HCM 2010, Exhibit 13-2

RAMP ADD OR DROP LANE ANALYSIS (MAINLINE <55 MPH)

ATKINS

General Information

Date Performed:	3/20/2014	Freeway/Direction	I-26 EB C-D
Analysis Year	2038 No Action	Junction	I-526 EB On
Analysis Time Period:	AM Peak	Segment ID	1090
Project Description:	Navy Base ICTF		

Inputs

	Mainline Upstream Ramp	Mainline Downstream Ramp	Ramp
Number of Lanes, N	1	1	1
Free-Flow Speed, FFS (mph)	55	55	45
Volume, V (veh/h)	566	865	299
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	8%	6%	3%
%RVs, P_R	0%	0%	0%

Performance Measures

	Upstream of Off-Ramp	Downstream of Off-Ramp	Off-Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.96	0.97	0.99
Demand Flow Rate, v_p (pc/h/ln)	654	990	337
Capacity Flow Rate, c (pc/h/ln)	2,200	2,200	2,100
v/c ratio	0.30	0.45	0.16
Density, D_{MD} (pc/mi/ln)	11.4	17.3	5.9
LOS	B	B	A

Formulas and Reference Material

$$f_{HV} = \frac{1}{1+P_T(E_T-1)+P_R(E_R-1)}$$ HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P}$$ HCM 2010, Equation 11-2

$$D_{MD} = \frac{0.0175*v_f}{N}$$ HCM 2010, Equation 13-26

Ramp Roadways Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

Diverge LOS Thresholds

LOS	Density (pc/mi/ln)
A	≤10
B	>10-20
C	>20-28
D	>28-35
E	>35
F	v/c > 1

Source: HCM 2010, Exhibit 13-2

RAMP ADD OR DROP LANE ANALYSIS (MAINLINE <55 MPH)

ATKINS

General Information

Date Performed:	7/25/2014	Freeway/Direction	I-26 EB C-D
Analysis Year	2038 No Action	Junction	I-526 EB On
Analysis Time Period:	PM Peak	Segment ID	1090
Project Description:	Navy Base ICTF		

Inputs

	Mainline Upstream Ramp	Mainline Downstream Ramp	Ramp
Number of Lanes, N	1	1	1
Free-Flow Speed, FFS (mph)	55	55	45
Volume, V (veh/h)	498	842	344
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	7%	5%	3%
%RVs, P_R	0%	0%	0%

Performance Measures

	Upstream of Off-Ramp	Downstream of Off-Ramp	Off-Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.97	0.98	0.99
Demand Flow Rate, v_p (pc/h/ln)	573	959	388
Capacity Flow Rate, c (pc/h/ln)	2,200	2,200	2,100
v/c ratio	0.26	0.44	0.18
Density, D_{MD} (pc/mi/ln)	10.0	16.8	6.8
LOS	A	B	A

Formulas and Reference Material

$$f_{HV} = \frac{1}{1+P_T(E_T-1)+P_R(E_R-1)}$$ HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P}$$ HCM 2010, Equation 11-2

$$D_{MD} = \frac{0.0175*v_f}{N}$$ HCM 2010, Equation 13-26

Ramp Roadways Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

Diverge LOS Thresholds

LOS	Density (pc/mi/ln)
A	≤10
B	>10-20
C	>20-28
D	>28-35
E	>35
F	v/c > 1

Source: HCM 2010, Exhibit 13-2

Navy Base ICTF

FREEWAY WEAVING WORKSHEET

General Information

Analyst	AJR
Agency/Company	Atkins
Date Performed	7/25/2014
Analysis Time Period	AM Peak

Site Information

Freeway/Dir of Travel	I-26 EB
Weaving Segment Location	1100 - I-526 CD to Montague SB
Analysis Year	2038 No Action

Project Description *Navy Base ICTF*

Inputs

Weaving configuration	One-Sided
Weaving number of lanes, N	4
Weaving segment length, L_S	1550ft
Freeway free-flow speed, FFS	60 mph
Segment type	Freeway
Freeway minimum speed, S_{MIN}	15
Freeway maximum capacity, C_{IFL}	2300
Terrain type	Level

Conversions to pc/h Under Base Conditions

	V (veh/h)	PHF	Truck (%)	RV (%)	E_T	E_R	f_{HV}	f_p	v (pc/h)
V_{FF}	4364	0.90	8	0	1.5	1.2	0.962	1.00	5043
V_{RF}	751	0.90	8	0	1.5	1.2	0.962	1.00	868
V_{FR}	666	0.90	15	0	1.5	1.2	0.930	1.00	796
V_{RR}	114	0.90	15	0	1.5	1.2	0.930	1.00	136
V_{NW}	5179							V =	6843
V_W	1664								
VR	0.243								

Configuration Characteristics

Minimum maneuver lanes, N_{WL}	2 lc	Minimum weaving lane changes, LC_{MIN}	1664 lc/h
Interchange density, ID	0.8 int/mi	Weaving lane changes, LC_W	2017 lc/h
Minimum RF lane changes, LC_{RF}	1 lc/pc	Non-weaving lane changes, LC_{NW}	1137 lc/h
Minimum FR lane changes, LC_{FR}	1 lc/pc	Total lane changes, LC_{ALL}	3154 lc/h
Minimum RR lane changes, LC_{RR}	lc/pc	Non-weaving vehicle index, I_{NW}	642

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment flow rate, v	6843 pc/h	Weaving intensity factor, W	0.396
Weaving segment capacity, c_w	7835 veh/h	Weaving segment speed, S	41.4 mph
Weaving segment v/c ratio	0.840	Average weaving speed, S_W	47.2 mph
Weaving segment density, D	41.3 pc/mi/ln	Average non-weaving speed, S_{NW}	39.8 mph
Level of Service, LOS	E	Maximum weaving length, L_{MAX}	4982 ft

Notes

a. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments".
b. For volumes that exceed the weaving segment capacity, the level of service is "F".

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Navy Base ICTF

FREEWAY WEAVING WORKSHEET

General Information

Analyst	AJR
Agency/Company	Atkins
Date Performed	3/20/2014
Analysis Time Period	PM Peak

Site Information

Freeway/Dir of Travel	I-26 EB
Weaving Segment Location	1100 - I-526 CD to Montague SB
Analysis Year	2038 No Action

Project Description *Navy Base ICTF*

Inputs

Weaving configuration	One-Sided	Segment type	Freeway
Weaving number of lanes, N	4	Freeway minimum speed, S_{MIN}	15
Weaving segment length, L_S	1550ft	Freeway maximum capacity, C_{IFL}	2300
Freeway free-flow speed, FFS	60 mph	Terrain type	Level

Conversions to pc/h Under Base Conditions

	V (veh/h)	PHF	Truck (%)	RV (%)	E_T	E_R	f_{HV}	f_p	v (pc/h)
V_{FF}	2551	0.90	6	0	1.5	1.2	0.971	1.00	2919
V_{RF}	611	0.90	6	0	1.5	1.2	0.971	1.00	699
V_{FR}	967	0.90	8	0	1.5	1.2	0.962	1.00	1117
V_{RR}	231	0.90	8	0	1.5	1.2	0.962	1.00	267
V_{NW}	3186							V =	5002
V_W	1816								
VR	0.363								

Configuration Characteristics

Minimum maneuver lanes, N_{WL}	2 lc	Minimum weaving lane changes, LC_{MIN}	1816 lc/h
Interchange density, ID	0.8 int/mi	Weaving lane changes, LC_W	2169 lc/h
Minimum RF lane changes, LC_{RF}	1 lc/pc	Non-weaving lane changes, LC_{NW}	726 lc/h
Minimum FR lane changes, LC_{FR}	1 lc/pc	Total lane changes, LC_{ALL}	2895 lc/h
Minimum RR lane changes, LC_{RR}	lc/pc	Non-weaving vehicle index, I_{NW}	395

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment flow rate, v	5002 pc/h	Weaving intensity factor, W	0.370
Weaving segment capacity, c_w	6418 veh/h	Weaving segment speed, S	43.2 mph
Weaving segment v/c ratio	0.757	Average weaving speed, S_W	47.8 mph
Weaving segment density, D	29.0 pc/mi/ln	Average non-weaving speed, S_{NW}	40.9 mph
Level of Service, LOS	D	Maximum weaving length, L_{MAX}	6270 ft

Notes

a. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments".
b. For volumes that exceed the weaving segment capacity, the level of service is "F".

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-26 EB*
Agency or Company	*Atkins*	From/To	*1105-Mont SB Off to Mont SB On*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2038 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*5115*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*8*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.962*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*3*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*60.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*60.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1970*	pc/h/ln
S	*57.5*	mph
D = v_p / S	*34.3*	pc/mi/ln
LOS	*D*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-26 EB*
Agency or Company	*Atkins*	From/To	*1105-Mont SB Off to Mont SB On*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*PM Peak*	Analysis Year	*2038 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*3162*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*6*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.971*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*3*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*60.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*60.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1206*	pc/h/ln
S	*60.0*	mph
D = v_p / S	*20.1*	pc/mi/ln
LOS	*C*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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Navy Base ICTF

FREEWAY WEAVING WORKSHEET

General Information

Analyst	AJR
Agency/Company	Atkins
Date Performed	7/25/2014
Analysis Time Period	AM Peak

Site Information

Freeway/Dir of Travel	I-26 EB
Weaving Segment Location	1110 - Montague SB to Mont. NB
Analysis Year	2038 No Action

Project Description *Navy Base ICTF*

Inputs

Weaving configuration	One-Sided	Segment type	Freeway
Weaving number of lanes, N	4	Freeway minimum speed, S_{MIN}	15
Weaving segment length, L_S	470ft	Freeway maximum capacity, C_{IFL}	2300
Freeway free-flow speed, FFS	60 mph	Terrain type	Level

Conversions to pc/h Under Base Conditions

	V (veh/h)	PHF	Truck (%)	RV (%)	E_T	E_R	f_{HV}	fp	v (pc/h)
V_{FF}	4598	0.90	8	0	1.5	1.2	0.962	1.00	5313
V_{RF}	453	0.90	15	0	1.5	1.2	0.930	1.00	541
V_{FR}	517	0.90	6	0	1.5	1.2	0.971	1.00	592
V_{RR}	0	0.90	0	0	1.5	1.2	1.000	1.00	0
V_{NW}	5313							V =	6446
V_W	1133								
VR	0.176								

Configuration Characteristics

Minimum maneuver lanes, N_{WL}	2 lc	Minimum weaving lane changes, LC_{MIN}	1133 lc/h
Interchange density, ID	1.0 int/mi	Weaving lane changes, LC_W	1275 lc/h
Minimum RF lane changes, LC_{RF}	1 lc/pc	Non-weaving lane changes, LC_{NW}	579 lc/h
Minimum FR lane changes, LC_{FR}	1 lc/pc	Total lane changes, LC_{ALL}	1854 lc/h
Minimum RR lane changes, LC_{RR}	lc/pc	Non-weaving vehicle index, I_{NW}	250

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment flow rate, v	6446 pc/h	Weaving intensity factor, W	0.667
Weaving segment capacity, c_w	7723 veh/h	Weaving segment speed, S	43.7 mph
Weaving segment v/c ratio	0.803	Average weaving speed, S_W	42.0 mph
Weaving segment density, D	36.9 pc/mi/ln	Average non-weaving speed, S_{NW}	44.1 mph
Level of Service, LOS	E	Maximum weaving length, L_{MAX}	4290 ft

Notes

a. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments".
b. For volumes that exceed the weaving segment capacity, the level of service is "F".

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Navy Base ICTF

FREEWAY WEAVING WORKSHEET

General Information

Analyst	AJR
Agency/Company	Atkins
Date Performed	7/25/2014
Analysis Time Period	PM Peak

Site Information

Freeway/Dir of Travel	I-26 EB
Weaving Segment Location	1110 - Montague SB to Mont. NB
Analysis Year	2038 No Action

Project Description *Navy Base ICTF*

Inputs

Weaving configuration	One-Sided	Segment type	Freeway
Weaving number of lanes, N	4	Freeway minimum speed, S_{MIN}	15
Weaving segment length, L_S	470ft	Freeway maximum capacity, C_{IFL}	2300
Freeway free-flow speed, FFS	60 mph	Terrain type	Level

Conversions to pc/h Under Base Conditions

	V (veh/h)	PHF	Truck (%)	RV (%)	E_T	E_R	f_{HV}	f_p	v (pc/h)
V_{FF}	2871	0.90	6	0	1.5	1.2	0.971	1.00	3286
V_{RF}	573	0.90	10	0	1.5	1.2	0.952	1.00	669
V_{FR}	291	0.90	9	0	1.5	1.2	0.957	1.00	338
V_{RR}	0	0.90	0	0	1.5	1.2	1.000	1.00	0
V_{NW}	3286							V =	4293
V_W	1007								
VR	0.235								

Configuration Characteristics

Minimum maneuver lanes, N_{WL}	2 lc	Minimum weaving lane changes, LC_{MIN}	1007 lc/h
Interchange density, ID	1.0 int/mi	Weaving lane changes, LC_W	1149 lc/h
Minimum RF lane changes, LC_{RF}	1 lc/pc	Non-weaving lane changes, LC_{NW}	161 lc/h
Minimum FR lane changes, LC_{FR}	1 lc/pc	Total lane changes, LC_{ALL}	1310 lc/h
Minimum RR lane changes, LC_{RR}	lc/pc	Non-weaving vehicle index, I_{NW}	154

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment flow rate, v	4293 pc/h	Weaving intensity factor, W	0.507
Weaving segment capacity, c_w	7619 veh/h	Weaving segment speed, S	46.9 mph
Weaving segment v/c ratio	0.547	Average weaving speed, S_W	44.9 mph
Weaving segment density, D	22.9 pc/mi/ln	Average non-weaving speed, S_{NW}	47.6 mph
Level of Service, LOS	C	Maximum weaving length, L_{MAX}	4893 ft

Notes

a. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments".
b. For volumes that exceed the weaving segment capacity, the level of service is "F".

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-26 EB*
Agency or Company	*Atkins*	From/To	*1115-Mont NB Off to Mont NB On*
Date Performed	*4/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2038 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*5051*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*8*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.962*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*3*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*60.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*60.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1946*	pc/h/ln
S	*57.8*	mph
D = v_p / S	*33.7*	pc/mi/ln
LOS	*D*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-26 EB*
Agency or Company	*Atkins*	From/To	*1115-Mont NB Off to Mont NB On*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*PM Peak*	Analysis Year	*2038 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*3444*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*6*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.971*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*3*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*60.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*60.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1314*	pc/h/ln
S	*60.0*	mph
D = v_p / S	*21.9*	pc/mi/ln
LOS	*C*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-26 EB
Agency or Company	Atkins	Junction	1120 - EB On from Montague NB
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2038 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Freeway Number of Lanes, N: 3	☐ Yes ☐ On
☑ No ☐ Off	Ramp Number of Lanes, N: 1	☑ No ☐ Off
L_{up} = ft	Acceleration Lane Length, L_A: 850	L_{down} = ft
V_u = veh/h	Deceleration Lane Length L_D	V_D = veh/h
	Freeway Volume, V_F: 5051	
	Ramp Volume, V_R: 719	
	Freeway Free-Flow Speed, S_{FF}: 60.0	
	Ramp Free-Flow Speed, S_{FR}: 45.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	5051	0.90	Level	8	0	0.962	1.00	5837
Ramp	719	0.90	Level	8	0	0.962	1.00	831
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 0.601 using Equation (Exhibit 13-6)

V_{12} = 3510 pc/h

V_3 or V_{av34} 2327 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * $V_{12}/2$ ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	6668	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	4341	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = 33.6 (pc/mi/ln)

LOS = D (Exhibit 13-2)

Speed Determination

M_S = 0.544 (Exibit 13-11)

S_R= 50.2 mph (Exhibit 13-11)

S_0= 53.3 mph (Exhibit 13-11)

S = 51.2 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * $V_{12}/2$ ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-26 EB
Agency or Company	Atkins	Junction	1120 - EB On from Montague NB
Date Performed	4/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2038 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Number of Lanes, N: 3	☐ Yes ☐ On
☑ No ☐ Off	Acceleration Lane Length, L_A: 850	☑ No ☐ Off
L_{up} = ft	Deceleration Lane Length L_D	L_{down} = ft
V_u = veh/h	Freeway Volume, V_F: 3444	V_D = veh/h
	Ramp Volume, V_R: 779	
	Freeway Free-Flow Speed, S_{FF}: 60.0	
	Ramp Free-Flow Speed, S_{FR}: 45.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	3444	0.90	Level	6	0	0.971	1.00	3941
Ramp	779	0.90	Level	6	0	0.971	1.00	892
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 0.601 using Equation (Exhibit 13-6)

V_{12} = 2370 pc/h

V_3 or V_{av34} 1571 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * $V_{12}/2$ ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	4833	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	3262	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = 25.2 (pc/mi/ln)

LOS = C (Exhibit 13-2)

Speed Determination

M_S = 0.346 (Exibit 13-11)

S_R= 53.8 mph (Exhibit 13-11)

S_0= 56.1 mph (Exhibit 13-11)

S = 54.5 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * $V_{12}/2$ ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-26 EB*
Agency or Company	*Atkins*	From/To	*1130 - Montague to Dorchester*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2038 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*5770*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*7*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.966*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*3*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*60.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*60.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*2212*	pc/h/ln
S	*53.2*	mph
D = v_p / S	*41.6*	pc/mi/ln
LOS	*E*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-26 EB*
Agency or Company	*Atkins*	From/To	*1130 - Montague to Dorchester*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*PM Peak*	Analysis Year	*2038 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*4223*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*6*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.971*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*3*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*60.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*60.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1611*	pc/h/ln
S	*60.0*	mph
D = v_p / S	*26.9*	pc/mi/ln
LOS	*D*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-26 EB
Agency or Company	Atkins	Junction	1140-EB Off to Dorchester Rd
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2038 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Number of Lanes, N	3	Downstream Adj Ramp	
☐ Yes	☐ On	Acceleration Lane Length, L_A		☐ Yes	☐ On
☑ No	☐ Off	Deceleration Lane Length L_D	380	☑ No	☐ Off
L_{up} =	ft	Freeway Volume, V_F	5770	L_{down} =	ft
V_u =	veh/h	Ramp Volume, V_R	576	V_D =	veh/h
		Freeway Free-Flow Speed, S_{FF}	60.0		
		Ramp Free-Flow Speed, S_{FR}	45.0		

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	5770	0.90	Level	7	0	0.966	1.00	6635
Ramp	576	0.90	Level	11	0	0.948	1.00	675
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 0.563 using Equation (Exhibit 13-7)

V_{12} = 4031 pc/h

V_3 or V_{av34} 2604 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	6635	Exhibit 13-8	6900	No
$V_{FO} = V_F - V_R$	5960	Exhibit 13-8	6900	No
V_R	675	Exhibit 13-10	2100	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	4031	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = 35.5 (pc/mi/ln)

LOS = E (Exhibit 13-2)

Speed Determination

D_s = 0.359 (Exhibit 13-12)

S_R= 53.5 mph (Exhibit 13-12)

S_0= 59.6 mph (Exhibit 13-12)

S = 55.8 mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-26 EB
Agency or Company	Atkins	Junction	1140-EB Off to Dorchester Rd
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2038 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Freeway Number of Lanes, N: 3	☐ Yes ☐ On
☑ No ☐ Off	Ramp Number of Lanes, N: 1	☑ No ☐ Off
L_{up} = ft	Acceleration Lane Length, L_A	L_{down} = ft
V_u = veh/h	Deceleration Lane Length L_D: 380	V_D = veh/h
	Freeway Volume, V_F: 4223	
	Ramp Volume, V_R: 396	
	Freeway Free-Flow Speed, S_{FF}: 60.0	
	Ramp Free-Flow Speed, S_{FR}: 45.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	4223	0.90	Level	6	0	0.971	1.00	4833
Ramp	396	0.90	Level	14	0	0.935	1.00	471
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 0.618 using Equation (Exhibit 13-7)

V_{12} = 3165 pc/h

V_3 or V_{av34} 1668 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	4833	Exhibit 13-8	6900	No
$V_{FO} = V_F - V_R$	4362	Exhibit 13-8	6900	No
V_R	471	Exhibit 13-10	2100	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	3165	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = 28.1 (pc/mi/ln)

LOS = D (Exhibit 13-2)

Speed Determination

D_s = 0.340 (Exhibit 13-12)

S_R= 53.9 mph (Exhibit 13-12)

S_0= 63.2 mph (Exhibit 13-12)

S = 56.8 mph (Exhibit 13-13)

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-26 EB*
Agency or Company	*Atkins*	From/To	*1145-Dorches Off to Dorches On*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2038 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*5194*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*8*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.962*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*3*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*60.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*60.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*2001*	pc/h/ln
S	*57.1*	mph
D = v_p / S	*35.1*	pc/mi/ln
LOS	*E*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-26 EB*
Agency or Company	*Atkins*	From/To	*1145-Dorches Off to Dorches On*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*PM Peak*	Analysis Year	*2038 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*3827*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*7*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.966*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*3*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*60.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*60.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1467*	pc/h/ln
S	*60.0*	mph
D = v_p / S	*24.5*	pc/mi/ln
LOS	*C*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-26 EB
Agency or Company	Atkins	Junction	1150 - EB On from Dorchester
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2038 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Freeway Number of Lanes, N: 3	☑ Yes ☐ On
☑ No ☐ Off	Ramp Number of Lanes, N: 1	☐ No ☑ Off
L_{up} = ft	Acceleration Lane Length, L_A: 560	L_{down} = 2100 ft
V_u = veh/h	Deceleration Lane Length L_D:	V_D = 851 veh/h
	Freeway Volume, V_F: 5194	
	Ramp Volume, V_R: 719	
	Freeway Free-Flow Speed, S_{FF}: 60.0	
	Ramp Free-Flow Speed, S_{FR}: 45.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	5194	0.90	Level	8	0	0.962	1.00	6002
Ramp	719	0.90	Level	11	0	0.948	1.00	843
UpStream								
DownStream	851	0.90	Level	13	0	0.939	1.00	1007

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = 5940.30 (Equation 13-6 or 13-7)

P_{FM} = 0.675 using Equation (Exhibit 13-6)

V_{12} = 4050 pc/h

V_3 or V_{av34} 1952 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * $V_{12}/2$ ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	6845	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	4893	Exhibit 13-8	4600:All	Yes

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = 39.7 (pc/mi/ln)

LOS = E (Exhibit 13-2)

Speed Determination

M_S = 0.791 (Exibit 13-11)

S_R= 45.8 mph (Exhibit 13-11)

S_0= 54.8 mph (Exhibit 13-11)

S = 48.0 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * $V_{12}/2$ ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-26 EB
Agency or Company	Atkins	Junction	1150 - EB On from Dorchester
Date Performed	4/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2038 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Freeway Number of Lanes, N: 3	☑ Yes ☐ On
☑ No ☐ Off	Ramp Number of Lanes, N: 1	☐ No ☑ Off
L_{up} = ft	Acceleration Lane Length, L_A: 560	L_{down} = 2100 ft
V_u = veh/h	Deceleration Lane Length L_D:	V_D = 1222 veh/h
	Freeway Volume, V_F: 3827	
	Ramp Volume, V_R: 534	
	Freeway Free-Flow Speed, S_{FF}: 60.0	
	Ramp Free-Flow Speed, S_{FR}: 45.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	3827	0.90	Level	7	0	0.966	1.00	4401
Ramp	534	0.90	Level	13	0	0.939	1.00	632
UpStream								
DownStream	1222	0.90	Level	8	0	0.962	1.00	1412

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = 8329.40 (Equation 13-6 or 13-7)

P_{FM} = 0.725 using Equation (Exhibit 13-6)

V_{12} = 3192 pc/h

V_3 or V_{av34} 1209 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * $V_{12}/2$ ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	5033	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	3824	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = 31.5 (pc/mi/ln)

LOS = D (Exhibit 13-2)

Speed Determination

M_S = 0.449 (Exibit 13-11)

S_R= 51.9 mph (Exhibit 13-11)

S_0= 57.4 mph (Exhibit 13-11)

S = 53.1 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * $V_{12}/2$ ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-26 EB
Agency or Company	Atkins	Junction	1160-EB Off to Cosgrove SB
Date Performed	3/20/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2038 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp

☑ Yes ☑ On

☐ No ☐ Off

L_{up} = 2100 ft

V_u = 719 veh/h

Freeway Number of Lanes, N	3
Ramp Number of Lanes, N	1
Acceleration Lane Length, L_A	
Deceleration Lane Length L_D	200
Freeway Volume, V_F	5913
Ramp Volume, V_R	851
Freeway Free-Flow Speed, S_{FF}	60.0
Ramp Free-Flow Speed, S_{FR}	45.0

Downstream Adj Ramp

☐ Yes ☐ On

☑ No ☐ Off

L_{down} = ft

V_D = veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	5913	0.90	Level	8	0	0.962	1.00	6833
Ramp	851	0.90	Level	13	0	0.939	1.00	1007
UpStream	719	0.90	Level	11	0	0.948	1.00	843
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = 5559.70 (Equation 13-12 or 13-13)

P_{FD} = 0.543 using Equation (Exhibit 13-7)

V_{12} = 4170 pc/h

V_3 or V_{av34} 2663 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	6833	Exhibit 13-8	6900	No
$V_{FO} = V_F - V_R$	5826	Exhibit 13-8	6900	No
V_R	1007	Exhibit 13-10	2100	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	4170	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = 38.3 (pc/mi/ln)

LOS = E (Exhibit 13-2)

Speed Determination

D_s = 0.389 (Exhibit 13-12)

S_R= 53.0 mph (Exhibit 13-12)

S_0= 59.3 mph (Exhibit 13-12)

S = 55.3 mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-26 EB
Agency or Company	Atkins	Junction	1160-EB Off to Cosgrove SB
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2038 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp

☑ Yes ☑ On

☐ No ☐ Off

L_{up} = 2100 ft

V_u = 534 veh/h

Freeway Number of Lanes, N	3
Ramp Number of Lanes, N	1
Acceleration Lane Length, L_A	
Deceleration Lane Length L_D	200
Freeway Volume, V_F	4361
Ramp Volume, V_R	1222
Freeway Free-Flow Speed, S_{FF}	60.0
Ramp Free-Flow Speed, S_{FR}	45.0

Downstream Adj Ramp

☐ Yes ☐ On

☑ No ☐ Off

L_{down} = ft

V_D = veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	4361	0.90	Level	7	0	0.966	1.00	5015
Ramp	1222	0.90	Level	8	0	0.962	1.00	1412
UpStream	534	0.90	Level	13	0	0.939	1.00	632
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = 7996.66 (Equation 13-12 or 13-13)

P_{FD} = 0.570 using Equation (Exhibit 13-7)

V_{12} = 3465 pc/h

V_3 or V_{av34} 1550 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	5015	Exhibit 13-8	6900	No
$V_{FO} = V_F - V_R$	3603	Exhibit 13-8	6900	No
V_R	1412	Exhibit 13-10	2100	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	3465	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = 32.3 (pc/mi/ln)

LOS = D (Exhibit 13-2)

Speed Determination

D_s = 0.425 (Exhibit 13-12)

S_R= 52.3 mph (Exhibit 13-12)

S_0= 63.7 mph (Exhibit 13-12)

S = 55.4 mph (Exhibit 13-13)

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-26 EB*
Agency or Company	*Atkins*	From/To	*1165-Cosg SB Off to Cosg SB On*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2038 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*5062*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*8*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.962*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*3*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*60.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*60.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1950*	pc/h/ln
S	*57.8*	mph
D = v_p / S	*33.8*	pc/mi/ln
LOS	*D*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-26 EB*
Agency or Company	*Atkins*	From/To	*1165-Cosg SB Off to Cosg SB On*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*PM Peak*	Analysis Year	*2038 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*3139*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*7*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.966*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*3*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*60.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*60.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1203*	pc/h/ln
S	*60.0*	mph
D = v_p / S	*20.0*	pc/mi/ln
LOS	*C*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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Navy Base ICTF

FREEWAY WEAVING WORKSHEET

General Information

Analyst	AJR
Agency/Company	Atkins
Date Performed	7/25/2014
Analysis Time Period	AM Peak

Site Information

Freeway/Dir of Travel	I-26 EB
Weaving Segment Location	1170 - Cosgrove SB to Cos. NB
Analysis Year	2038 No Action

Project Description *Navy Base ICTF*

Inputs

Weaving configuration	One-Sided
Weaving number of lanes, N	4
Weaving segment length, L_S	600ft
Freeway free-flow speed, FFS	60 mph
Segment type	Freeway
Freeway minimum speed, S_{MIN}	15
Freeway maximum capacity, C_{IFL}	2300
Terrain type	Level

Conversions to pc/h Under Base Conditions

	V (veh/h)	PHF	Truck (%)	RV (%)	E_T	E_R	f_{HV}	f_p	v (pc/h)
V_{FF}	4759	0.90	8	0	1.5	1.2	0.962	1.00	5499
V_{RF}	440	0.90	2	0	1.5	1.2	0.990	1.00	494
V_{FR}	303	0.90	8	0	1.5	1.2	0.962	1.00	350
V_{RR}	0	0.90	0	0	1.5	1.2	1.000	1.00	0
V_{NW}	5499							V =	6343
V_W	844								
VR	0.133								

Configuration Characteristics

Minimum maneuver lanes, N_{WL}	2 lc	Minimum weaving lane changes, LC_{MIN}	844 lc/h
Interchange density, ID	1.0 int/mi	Weaving lane changes, LC_W	1032 lc/h
Minimum RF lane changes, LC_{RF}	1 lc/pc	Non-weaving lane changes, LC_{NW}	688 lc/h
Minimum FR lane changes, LC_{FR}	1 lc/pc	Total lane changes, LC_{ALL}	1720 lc/h
Minimum RR lane changes, LC_{RR}	lc/pc	Non-weaving vehicle index, I_{NW}	330

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment flow rate, v	6343 pc/h	Weaving intensity factor, W	0.519
Weaving segment capacity, c_w	7885 veh/h	Weaving segment speed, S	46.1 mph
Weaving segment v/c ratio	0.773	Average weaving speed, S_W	44.6 mph
Weaving segment density, D	34.4 pc/mi/ln	Average non-weaving speed, S_{NW}	46.3 mph
Level of Service, LOS	D	Maximum weaving length, L_{MAX}	3863 ft

Notes

a. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments".
b. For volumes that exceed the weaving segment capacity, the level of service is "F".

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Navy Base ICTF

FREEWAY WEAVING WORKSHEET

General Information

Analyst	AJR
Agency/Company	Atkins
Date Performed	7/25/2014
Analysis Time Period	PM Peak

Site Information

Freeway/Dir of Travel	I-26 EB
Weaving Segment Location	1170 - Cosgrove SB to Cos. NB
Analysis Year	2038 No Action

Project Description *Navy Base ICTF*

Inputs

Weaving configuration	One-Sided	Segment type	Freeway
Weaving number of lanes, N	4	Freeway minimum speed, S_{MIN}	15
Weaving segment length, L_S	600ft	Freeway maximum capacity, C_{IFL}	2300
Freeway free-flow speed, FFS	60 mph	Terrain type	Level

Conversions to pc/h Under Base Conditions

	V (veh/h)	PHF	Truck (%)	RV (%)	E_T	E_R	f_{HV}	f_p	v (pc/h)
V_{FF}	2996	0.90	7	0	1.5	1.2	0.966	1.00	3445
V_{RF}	452	0.90	2	0	1.5	1.2	0.990	1.00	507
V_{FR}	143	0.90	14	0	1.5	1.2	0.935	1.00	170
V_{RR}	0	0.90	0	0	1.5	1.2	1.000	1.00	0
V_{NW}	3445							V =	4122
V_W	677								
VR	0.164								

Configuration Characteristics

Minimum maneuver lanes, N_{WL}	2 lc	Minimum weaving lane changes, LC_{MIN}	677 lc/h
Interchange density, ID	1.0 int/mi	Weaving lane changes, LC_W	865 lc/h
Minimum RF lane changes, LC_{RF}	1 lc/pc	Non-weaving lane changes, LC_{NW}	264 lc/h
Minimum FR lane changes, LC_{FR}	1 lc/pc	Total lane changes, LC_{ALL}	1129 lc/h
Minimum RR lane changes, LC_{RR}	lc/pc	Non-weaving vehicle index, I_{NW}	207

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment flow rate, v	4122 pc/h	Weaving intensity factor, W	0.372
Weaving segment capacity, c_w	7834 veh/h	Weaving segment speed, S	49.8 mph
Weaving segment v/c ratio	0.508	Average weaving speed, S_W	47.8 mph
Weaving segment density, D	20.7 pc/mi/ln	Average non-weaving speed, S_{NW}	50.2 mph
Level of Service, LOS	C	Maximum weaving length, L_{MAX}	4174 ft

Notes

a. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments".
b. For volumes that exceed the weaving segment capacity, the level of service is "F".

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-26 EB*
Agency or Company	*Atkins*	From/To	*1175-Cosg NB Off to Cosg NB On*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2038 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*5199*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*8*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.962*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*3*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*60.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*60.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*2003*	pc/h/ln
S	*57.1*	mph
D = v_p / S	*35.1*	pc/mi/ln
LOS	*E*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-26 EB*
Agency or Company	*Atkins*	From/To	*1175-Cosg NB Off to Cosg NB On*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*PM Peak*	Analysis Year	*2038 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*3448*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*7*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.966*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*3*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*60.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*60.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1322*	pc/h/ln
S	*60.0*	mph
D = v_p / S	*22.0*	pc/mi/ln
LOS	*C*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-26 EB
Agency or Company	Atkins	Junction	1180 - EB On from Cosgrove NB
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2038 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Number of Lanes, N	3	Downstream Adj Ramp	
☐ Yes	☐ On	Acceleration Lane Length, L_A	440	☐ Yes	☐ On
☑ No	☐ Off	Deceleration Lane Length L_D		☑ No	☐ Off
L_{up} =	ft	Freeway Volume, V_F	5199	L_{down} =	ft
V_u =	veh/h	Ramp Volume, V_R	899	V_D =	veh/h
		Freeway Free-Flow Speed, S_{FF}	60.0		
		Ramp Free-Flow Speed, S_{FR}	45.0		

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	5199	0.90	Level	8	0	0.962	1.00	6008
Ramp	899	0.90	Level	16	0	0.926	1.00	1079
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 0.590 using Equation (Exhibit 13-6)

V_{12} = 3544 pc/h

V_3 or V_{av34} 2464 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * $V_{12}/2$ ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	7087	Exhibit 13-8		Yes

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	4623	Exhibit 13-8	4600:All	Yes

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = 38.3 (pc/mi/ln)

LOS = F (Exhibit 13-2)

Speed Determination

M_S = 0.678 (Exibit 13-11)

S_R= 47.8 mph (Exhibit 13-11)

S_0= 52.5 mph (Exhibit 13-11)

S = 49.3 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * $V_{12}/2$ ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-26 EB
Agency or Company	Atkins	Junction	1180 - EB On from Cosgrove NB
Date Performed	4/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2038 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Number of Lanes, N: 3	☐ Yes ☐ On
☑ No ☐ Off	Acceleration Lane Length, L_A: 440	☑ No ☐ Off
L_{up} = ft	Deceleration Lane Length L_D:	L_{down} = ft
V_u = veh/h	Freeway Volume, V_F: 3448	V_D = veh/h
	Ramp Volume, V_R: 485	
	Freeway Free-Flow Speed, S_{FF}: 60.0	
	Ramp Free-Flow Speed, S_{FR}: 45.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	3448	0.90	Level	7	0	0.966	1.00	3965
Ramp	485	0.90	Level	26	0	0.885	1.00	609
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 0.590 using Equation (Exhibit 13-6)

V_{12} = 2339 pc/h

V_3 or V_{av34} 1626 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * $V_{12}/2$ ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	4574	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	2948	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = 25.4 (pc/mi/ln)

LOS = C (Exhibit 13-2)

Speed Determination

M_S = 0.356 (Exibit 13-11)

S_R= 53.6 mph (Exhibit 13-11)

S_0= 55.9 mph (Exhibit 13-11)

S = 54.4 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * $V_{12}/2$ ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-26 EB*
Agency or Company	*Atkins*	From/To	*1190 - Cosgrove to US-52*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2038 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*6098*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*8*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.962*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*3*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*60.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*60.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*2349*	pc/h/ln
S	*49.8*	mph
D = v_p / S	*47.2*	pc/mi/ln
LOS	*F*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-26 EB*
Agency or Company	*Atkins*	From/To	*1190 - Cosgrove to US-52*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*PM Peak*	Analysis Year	*2038 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*3933*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*7*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.966*

Speed Inputs			Calc Speed Adj and FFS		
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f_{LW}		mph
Number of Lanes, N	*3*		f_{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	*60.0*	mph	FFS	*60.0*	mph
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures			Design (N)	
Operational (LOS)			Design (N)	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1508*	pc/h/ln	Design LOS	
			v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h/ln
S	*60.0*	mph	S	mph
D = v_p / S	*25.1*	pc/mi/ln	D = v_p / S	pc/mi/ln
LOS	*C*		Required Number of Lanes, N	

Glossary		Factor Location	
N - Number of lanes	S - Speed	E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
V - Hourly volume	D - Density	E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 11-18	TRD - Page 11-11
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 11-2, 11-3	
DDHV - Directional design hour volume			

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-26 EB
Agency or Company	Atkins	Junction	1200-EB Off to US-52 & PAR
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2038 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Number of Lanes, N	3	Downstream Adj Ramp	
☐ Yes	☐ On	Acceleration Lane Length, L_A		☐ Yes	☐ On
☑ No	☐ Off	Deceleration Lane Length L_D	340	☑ No	☐ Off
L_{up} =	ft	Freeway Volume, V_F	6098	L_{down} =	ft
V_u =	veh/h	Ramp Volume, V_R	894	V_D =	veh/h
		Freeway Free-Flow Speed, S_{FF}	60.0		
		Ramp Free-Flow Speed, S_{FR}	45.0		

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	6098	0.90	Level	8	0	0.962	1.00	7047
Ramp	894	0.90	Level	24	0	0.893	1.00	1113
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 0.533 using Equation (Exhibit 13-7)

V_{12} = 4274 pc/h

V_3 or V_{av34} 2773 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☑ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = 4347 pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	7047	Exhibit 13-8	6900	Yes
$V_{FO} = V_F - V_R$	5934	Exhibit 13-8	6900	No
V_R	1113	Exhibit 13-10	2100	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	4274	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = 38.6 (pc/mi/ln)

LOS = F (Exhibit 13-2)

Speed Determination

D_s = 0.398 (Exhibit 13-12)

S_R= 52.8 mph (Exhibit 13-12)

S_0= 59.2 mph (Exhibit 13-12)

S = 55.1 mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-26 EB
Agency or Company	Atkins	Junction	1200-EB Off to US-52
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2038 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Number of Lanes, N	3	Downstream Adj Ramp	
☐ Yes	☐ On	Acceleration Lane Length, L_A		☐ Yes	☐ On
☑ No	☐ Off	Deceleration Lane Length L_D	340	☑ No	☐ Off
L_{up} =	ft	Freeway Volume, V_F	3933	L_{down} =	ft
V_u =	veh/h	Ramp Volume, V_R	744	V_D =	veh/h
		Freeway Free-Flow Speed, S_{FF}	60.0		
		Ramp Free-Flow Speed, S_{FR}	45.0		

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	3933	0.90	Level	7	0	0.966	1.00	4523
Ramp	744	0.90	Level	14	0	0.935	1.00	885
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 0.606 using Equation (Exhibit 13-7)

V_{12} = 3090 pc/h

V_3 or V_{av34} 1433 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	4523	Exhibit 13-8	6900	No
$V_{FO} = V_F - V_R$	3638	Exhibit 13-8	6900	No
V_R	885	Exhibit 13-10	2100	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	3090	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = 27.8 (pc/mi/ln)

LOS = C (Exhibit 13-2)

Speed Determination

D_s = 0.378 (Exhibit 13-12)

S_R= 53.2 mph (Exhibit 13-12)

S_0= 64.1 mph (Exhibit 13-12)

S = 56.2 mph (Exhibit 13-13)

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-26 EB*
Agency or Company	*Atkins*	From/To	*1205 - PAR Off to PAR On*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2038 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*5204*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*8*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.962*

Speed Inputs			Calc Speed Adj and FFS		
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f_{LW}		mph
Number of Lanes, N	*3*		f_{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	*60.0*	mph	FFS	*60.0*	mph
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures			Design (N)	
Operational (LOS)			Design (N)	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*2005*	pc/h/ln	Design LOS	
			v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h/ln
S	*57.0*	mph	S	mph
D = v_p / S	*35.2*	pc/mi/ln	D = v_p / S	pc/mi/ln
LOS	*E*		Required Number of Lanes, N	

Glossary		Factor Location	
N - Number of lanes	S - Speed	E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
V - Hourly volume	D - Density	E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 11-18	TRD - Page 11-11
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 11-2, 11-3	
DDHV - Directional design hour volume			

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F-3234

BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-26 EB*
Agency or Company	*Atkins*	From/To	*1205 - PAR Off to PAR On*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*PM Peak*	Analysis Year	*2038 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*3189*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*7*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.966*

Speed Inputs			Calc Speed Adj and FFS		
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f_{LW}		mph
Number of Lanes, N	*3*		f_{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	*60.0*	mph	FFS	*60.0*	mph
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures			Design (N)	
Operational (LOS)			Design (N)	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1222*	pc/h/ln	Design LOS	
			v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h/ln
S	*60.0*	mph	S	mph
D = v_p / S	*20.4*	pc/mi/ln	D = v_p / S	pc/mi/ln
LOS	*C*		Required Number of Lanes, N	

Glossary		Factor Location	
N - Number of lanes	S - Speed	E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
V - Hourly volume	D - Density	E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 11-18	TRD - Page 11-11
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 11-2, 11-3	
DDHV - Directional design hour volume			

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RAMP ADD OR DROP LANE ANALYSIS (MAINLINE <55 MPH)

ATKINS

General Information

Date Performed:	3/20/2014	Freeway/Direction	EB US-52 & PAR Off Ramp
Analysis Year	2038 No Action	Junction	US-52 & PAR EB Ramp Split
Analysis Time Period:	AM Peak	Segment ID	1208
Project Description:	Navy Base ICTF		

Inputs

	Mainline Upstream Ramp	Mainline Downstream Ramp	Ramp
Number of Lanes, N	1	1	1
Free-Flow Speed, FFS (mph)	45	55	45
Volume, V (veh/h)	894	557	337
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	24%	13%	43%
%RVs, P_R	0%	0%	0%

Performance Measures

	Upstream of Off-Ramp	Downstream of Off-Ramp	Off-Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.89	0.94	0.82
Demand Flow Rate, v_p (pc/h/ln)	1,113	659	455
Capacity Flow Rate, c (pc/h/ln)	2,100	2,200	2,100
v/c ratio	0.53	0.30	0.22
Density, D_{MD} (pc/mi/ln)	19.5	11.5	8.0
LOS	B	B	A

Formulas and Reference Material

$$f_{HV} = \frac{1}{1+P_T(E_T-1)+P_R(E_R-1)}$$ HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P}$$ HCM 2010, Equation 11-2

$$D_{MD} = \frac{0.0175*v_f}{N}$$ HCM 2010, Equation 13-26

Ramp Roadways Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

Diverge LOS Thresholds

LOS	Density (pc/mi/ln)
A	≤10
B	>10-20
C	>20-28
D	>28-35
E	>35
F	v/c > 1

Source: HCM 2010, Exhibit 13-2

RAMP ADD OR DROP LANE ANALYSIS (MAINLINE <55 MPH)

ATKINS

General Information

Date Performed:	3/20/2014	Freeway/Direction	EB US-52 & PAR Off Ramp
Analysis Year	2038 No Action	Junction	US-52 & PAR EB Ramp Split
Analysis Time Period:	PM Peak	Segment ID	1208
Project Description:	Navy Base ICTF		

Inputs

	Mainline Upstream Ramp	Mainline Downstream Ramp	Ramp
Number of Lanes, N	1	1	1
Free-Flow Speed, FFS (mph)	45	55	45
Volume, V (veh/h)	744	626	118
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	14%	10%	38%
%RVs, P_R	0%	0%	0%

Performance Measures

	Upstream of Off-Ramp	Downstream of Off-Ramp	Off-Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.93	0.95	0.84
Demand Flow Rate, v_p (pc/h/ln)	885	730	156
Capacity Flow Rate, c (pc/h/ln)	2,100	2,200	2,100
v/c ratio	0.42	0.33	0.07
Density, D_{MD} (pc/mi/ln)	15.5	12.8	2.7
LOS	B	B	A

Formulas and Reference Material

$$f_{HV} = \frac{1}{1 + P_T(E_T-1)+P_R(E_R-1)}$$ HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P}$$ HCM 2010, Equation 11-2

$$D_{MD} = \frac{0.0175*v_f}{N}$$ HCM 2010, Equation 13-26

Ramp Roadways Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

Diverge LOS Thresholds

LOS	Density (pc/mi/ln)
A	≤10
B	>10-20
C	>20-28
D	>28-35
E	>35
F	v/c > 1

Source: HCM 2010, Exhibit 13-2

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-26 EB
Agency or Company	Atkins	Junction	1210 - EB On from PAR
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2038 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Number of Lanes, N: 3	☐ Yes ☐ On
☑ No ☐ Off	Acceleration Lane Length, L_A: 1000	☑ No ☐ Off
L_{up} = ft	Deceleration Lane Length L_D:	L_{down} = ft
V_u = veh/h	Freeway Volume, V_F: 5204	V_D = veh/h
	Ramp Volume, V_R: 294	
	Freeway Free-Flow Speed, S_{FF}: 60.0	
	Ramp Free-Flow Speed, S_{FR}: 55.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	5204	0.90	Level	8	0	0.962	1.00	6014
Ramp	294	0.90	Level	43	0	0.823	1.00	397
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 0.605 using Equation (Exhibit 13-6)

V_{12} = 3641 pc/h

V_3 or V_{av34} 2373 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * $V_{12}/2$ ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	6411	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	4038	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = 30.5 (pc/mi/ln)

LOS = D (Exhibit 13-2)

Speed Determination

M_S = 0.432 (Exibit 13-11)

S_R= 52.2 mph (Exhibit 13-11)

S_0= 53.0 mph (Exhibit 13-11)

S = 52.5 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * $V_{12}/2$ ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-26 EB
Agency or Company	Atkins	Junction	1210 - EB On from PAR
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2038 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Number of Lanes, N: 3	☐ Yes ☐ On
☑ No ☐ Off	Acceleration Lane Length, L_A: 1000	☑ No ☐ Off
L_{up} = ft	Deceleration Lane Length L_D:	L_{down} = ft
V_u = veh/h	Freeway Volume, V_F: 3189	V_D = veh/h
	Ramp Volume, V_R: 571	
	Freeway Free-Flow Speed, S_{FF}: 60.0	
	Ramp Free-Flow Speed, S_{FR}: 55.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	3189	0.90	Level	7	0	0.966	1.00	3667
Ramp	571	0.90	Level	38	0	0.840	1.00	755
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 0.605 using Equation (Exhibit 13-6)

V_{12} = 2220 pc/h

V_3 or V_{av34} 1447 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	4422	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	2975	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = 22.1 (pc/mi/ln)

LOS = C (Exhibit 13-2)

Speed Determination

M_S = 0.287 (Exibit 13-11)

S_R= 54.8 mph (Exhibit 13-11)

S_0= 56.6 mph (Exhibit 13-11)

S = 55.4 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-26 EB*
Agency or Company	*Atkins*	From/To	*1220 - PAR to Heriot*
Date Performed	*4/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2038 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*5498*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*6*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.971*

Speed Inputs			Calc Speed Adj and FFS		
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f_{LW}		mph
Number of Lanes, N	*3*		f_{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	*60.0*	mph	FFS	*60.0*	mph
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures			Design (N)	
Operational (LOS)			Design (N)	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*2097*	pc/h/ln	Design LOS	
			v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h/ln
S	*55.5*	mph	S	mph
D = v_p / S	*37.8*	pc/mi/ln	D = v_p / S	pc/mi/ln
LOS	*E*		Required Number of Lanes, N	

Glossary		Factor Location	
N - Number of lanes	S - Speed	E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
V - Hourly volume	D - Density	E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 11-18	TRD - Page 11-11
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 11-2, 11-3	
DDHV - Directional design hour volume			

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-26 EB*
Agency or Company	*Atkins*	From/To	*1220 - PAR to Heriot*
Date Performed	*4/25/2014*	Jurisdiction	
Analysis Time Period	*PM Peak*	Analysis Year	*2038 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*3760*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*5*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.976*

Speed Inputs			Calc Speed Adj and FFS		
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f_{LW}		mph
Number of Lanes, N	*3*		f_{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	*60.0*	mph	FFS	*60.0*	mph
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures			Design (N)	
Operational (LOS)			Design (N)	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1427*	pc/h/ln	Design LOS	
			v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h/ln
S	*60.0*	mph	S	mph
D = v_p / S	*23.8*	pc/mi/ln	D = v_p / S	pc/mi/ln
LOS	*C*		Required Number of Lanes, N	

Glossary		Factor Location	
N - Number of lanes	S - Speed	E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
V - Hourly volume	D - Density	E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 11-18	TRD - Page 11-11
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 11-2, 11-3	
DDHV - Directional design hour volume			

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-26 EB
Agency or Company	Atkins	Junction	1230-EB Off to Heriot St
Date Performed	3/20/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2038 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp

☐ Yes ☐ On

☑ No ☐ Off

L_{up} = ft

V_u = veh/h

Freeway Number of Lanes, N	3
Ramp Number of Lanes, N	1
Acceleration Lane Length, L_A	
Deceleration Lane Length L_D	200
Freeway Volume, V_F	5498
Ramp Volume, V_R	696
Freeway Free-Flow Speed, S_{FF}	55.0
Ramp Free-Flow Speed, S_{FR}	45.0

Downstream Adj Ramp

☑ Yes ☐ On

☐ No ☑ Off

L_{down} = 1400 ft

V_D = 804 veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	5498	0.90	Level	6	0	0.971	1.00	6292
Ramp	696	0.90	Level	5	0	0.976	1.00	793
UpStream								
DownStream	804	0.90	Level	10	0	0.952	1.00	938

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = 1431.30 (Equation 13-12 or 13-13)

P_{FD} = 0.567 using Equation (Exhibit 13-7)

V_{12} = 3911 pc/h

V_3 or V_{av34} 2381 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	6292	Exhibit 13-8	6750	No
$V_{FO} = V_F - V_R$	5499	Exhibit 13-8	6750	No
V_R	793	Exhibit 13-10	2100	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	3911	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = 36.1 (pc/mi/ln)

LOS = E (Exhibit 13-2)

Speed Determination

D_s = 0.369 (Exhibit 13-12)

S_R= 50.2 mph (Exhibit 13-12)

S_0= 54.9 mph (Exhibit 13-12)

S = 51.9 mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-26 EB
Agency or Company	Atkins	Junction	1230-EB Off to Heriot St
Date Performed	3/20/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2038 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Number of Lanes, N: 3	☑ Yes ☐ On
☑ No ☐ Off	Acceleration Lane Length, L_A	☐ No ☑ Off
L_{up} = ft	Deceleration Lane Length L_D: 200	L_{down} = 1400 ft
V_u = veh/h	Freeway Volume, V_F: 3760	V_D = 367 veh/h
	Ramp Volume, V_R: 492	
	Freeway Free-Flow Speed, S_{FF}: 55.0	
	Ramp Free-Flow Speed, S_{FR}: 45.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	3760	0.90	Level	5	0	0.976	1.00	4282
Ramp	492	0.90	Level	5	0	0.976	1.00	560
UpStream								
DownStream	367	0.90	Level	19	0	0.913	1.00	447

Estimation of v_{12}

Merge Areas

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * $V_{12}/2$ ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Diverge Areas

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = 554.68 (Equation 13-12 or 13-13)

P_{FD} = 0.627 using Equation (Exhibit 13-7)

V_{12} = 2894 pc/h

V_3 or V_{av34} 1388 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * $V_{12}/2$ ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

	Actual	Capacity		LOS F?
V_F	4282	Exhibit 13-8	6750	No
$V_{FO} = V_F - V_R$	3722	Exhibit 13-8	6750	No
V_R	560	Exhibit 13-10	2100	No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	2894	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = 27.3 (pc/mi/ln)

LOS = C (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Speed Determination

D_s = 0.348 (Exhibit 13-12)

S_R= 50.5 mph (Exhibit 13-12)

S_0= 58.8 mph (Exhibit 13-12)

S = 52.9 mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-26 EB
Agency or Company	Atkins	Junction	1240-EB Off to Mt. Pleasant St
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2038 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Freeway Number of Lanes, N	3	Downstream Adj Ramp	
☐ Yes	☐ On	Ramp Number of Lanes, N	1	☐ Yes	☐ On
☑ No	☐ Off	Acceleration Lane Length, L_A		☑ No	☐ Off
L_{up} =	ft	Deceleration Lane Length L_D	175	L_{down} =	ft
V_u =	veh/h	Freeway Volume, V_F	4802	V_D =	veh/h
		Ramp Volume, V_R	804		
		Freeway Free-Flow Speed, S_{FF}	55.0		
		Ramp Free-Flow Speed, S_{FR}	45.0		

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	4802	0.90	Level	6	0	0.971	1.00	5496
Ramp	804	0.90	Level	10	0	0.952	1.00	938
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 0.579 using Equation (Exhibit 13-7)

V_{12} = 3579 pc/h

V_3 or V_{av34} 1917 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	5496	Exhibit 13-8	6750	No
$V_{FO} = V_F - V_R$	4558	Exhibit 13-8	6750	No
V_R	938	Exhibit 13-10	2100	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	3579	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = 33.5 (pc/mi/ln)

LOS = D (Exhibit 13-2)

Speed Determination

D_s = 0.382 (Exhibit 13-12)

S_R= 50.0 mph (Exhibit 13-12)

S_0= 56.8 mph (Exhibit 13-12)

S = 52.2 mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-26 EB
Agency or Company	Atkins	Junction	1240-EB Off to Mt. Pleasant St
Date Performed	3/20/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2038 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Number of Lanes, N	3	Downstream Adj Ramp	
☐ Yes	☐ On	Acceleration Lane Length, L_A		☐ Yes	☐ On
☑ No	☐ Off	Deceleration Lane Length L_D	175	☑ No	☐ Off
L_{up} =	ft	Freeway Volume, V_F	3268	L_{down} =	ft
V_u =	veh/h	Ramp Volume, V_R	367	V_D =	veh/h
		Freeway Free-Flow Speed, S_{FF}	55.0		
		Ramp Free-Flow Speed, S_{FR}	45.0		

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	3268	0.90	Level	5	0	0.976	1.00	3722
Ramp	367	0.90	Level	19	0	0.913	1.00	447
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 0.646 using Equation (Exhibit 13-7)

V_{12} = 2564 pc/h

V_3 or V_{av34} 1158 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	3722	Exhibit 13-8	6750	No
$V_{FO} = V_F - V_R$	3275	Exhibit 13-8	6750	No
V_R	447	Exhibit 13-10	2100	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	2564	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = 24.7 (pc/mi/ln)

LOS = C (Exhibit 13-2)

Speed Determination

D_s = 0.338 (Exhibit 13-12)

S_R= 50.6 mph (Exhibit 13-12)

S_0= 59.7 mph (Exhibit 13-12)

S = 53.1 mph (Exhibit 13-13)

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FREEWAY RAMP ADD OR DROP LANE ANALYSIS

ATKINS

General Information

Date Performed:	7/25/2014	Freeway/Direction	I-26 EB
Analysis Year	2038 No Action	Junction	EB Off to US-17 NB
Analysis Time Period:	AM Peak	Segment ID	1250
Project Description:	Navy Base ICTF		

Inputs

	Freeway Upstream of Ramp	Freeway Downstream of Ramp	Ramp
Number of Lanes, N	3	2	1
Free-Flow Speed, FFS (mph)	55	55	55
Volume, V (veh/h)	3,998	2,545	1,453
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	5%	6%	4%
%RVs, P_R	0%	0%	0%

Performance Measures

	Freeway Upstream Ramp	Freeway Downstream Ramp	Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.98	0.97	0.98
Demand Flow Rate, v_p (pc/h/ln)	1,518	1,456	1,647
Capacity Flow Rate, c (pc/h/ln)	2,250	2,250	2,200
v/c ratio	0.67	0.65	0.75
Density, D_{MD} (pc/mi/ln)	26.6	25.5	28.8
LOS	C	C	D

Formulas and Reference Material

$$f_{HV} = \frac{1}{1 + P_T(E_T-1)+P_R(E_R-1)}$$ HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P}$$ HCM 2010, Equation 11-2

$$D_{MD} = \frac{0.0175*v_f}{N}$$ HCM 2010, Equation 13-26

Basic Freeway Segments Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
75	2,400
70	2,400
65	2,350
60	2,300
55	2,250

Source: HCM 2010, Exhibit 11-17

Ramp Roadways Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

Diverge LOS Thresholds

LOS	Density (pc/mi/ln)
A	≤10
B	>10-20
C	>20-28
D	>28-35
E	>35
F	v/c > 1

Source: HCM 2010, Exhibit 13-2

FREEWAY RAMP ADD OR DROP LANE ANALYSIS

ATKINS

General Information

Date Performed:	7/25/2014	Freeway/Direction	I-26 EB
Analysis Year	2038 No Action	Junction	EB Off to US-17 NB
Analysis Time Period:	PM Peak	Segment ID	1250
Project Description:	Navy Base ICTF		

Inputs

	Freeway Upstream of Ramp	Freeway Downstream of Ramp	Ramp
Number of Lanes, N	3	2	1
Free-Flow Speed, FFS (mph)	55	55	55
Volume, V (veh/h)	2,901	2,149	752
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	4%	5%	7%
%RVs, P_R	0%	0%	0%

Performance Measures

	Freeway Upstream Ramp	Freeway Downstream Ramp	Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.98	0.98	0.97
Demand Flow Rate, v_p (pc/h/ln)	1,096	1,224	865
Capacity Flow Rate, c (pc/h/ln)	2,250	2,250	2,200
v/c ratio	0.49	0.54	0.39
Density, D_{MD} (pc/mi/ln)	19.2	21.4	15.1
LOS	B	C	B

Formulas and Reference Material

$$f_{HV} = \frac{1}{1 + P_T(E_T-1)+P_R(E_R-1)}$$ HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P}$$ HCM 2010, Equation 11-2

$$D_{MD} = \frac{0.0175*v_f}{N}$$ HCM 2010, Equation 13-26

Basic Freeway Segments Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
75	2,400
70	2,400
65	2,350
60	2,300
55	2,250

Source: HCM 2010, Exhibit 11-17

Ramp Roadways Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

Diverge LOS Thresholds

LOS	Density (pc/mi/ln)
A	≤10
B	>10-20
C	>20-28
D	>28-35
E	>35
F	v/c > 1

Source: HCM 2010, Exhibit 13-2

BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-26 EB*
Agency or Company	*Atkins*	From/To	*1260 - US17 NB to Cypress St*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2038 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*2545*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*6*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.971*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*55.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*55.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1456*	pc/h/ln
S	*55.0*	mph
D = v_p / S	*26.5*	pc/mi/ln
LOS	*D*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-26 EB*
Agency or Company	*Atkins*	From/To	*1260 - US17 NB to Cypress St*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*PM Peak*	Analysis Year	*2038 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*2149*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*5*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.976*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*55.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*55.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1224*	pc/h/ln
S	*55.0*	mph
D = v_p / S	*22.3*	pc/mi/ln
LOS	*C*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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FREEWAY RAMP ADD OR DROP LANE ANALYSIS

ATKINS

General Information

Date Performed:	7/25/2014	Freeway/Direction	I-26 EB
Analysis Year	2038 No Action	Junction	EB On from Cypress St
Analysis Time Period:	AM Peak	Segment ID	1270
Project Description:	Navy Base ICTF		

Inputs

	Freeway Upstream of Ramp	Freeway Downstream of Ramp	Ramp
Number of Lanes, N	2	3	1
Free-Flow Speed, FFS (mph)	55	55	45
Volume, V (veh/h)	2,545	2,651	106
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	6%	5%	17%
%RVs, P_R	0%	0%	0%

Performance Measures

	Freeway Upstream Ramp	Freeway Downstream Ramp	Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.97	0.98	0.92
Demand Flow Rate, v_p (pc/h/ln)	1,456	1,006	128
Capacity Flow Rate, c (pc/h/ln)	2,250	2,250	2,100
v/c ratio	0.65	0.45	0.06
Density, D_{MD} (pc/mi/ln)	25.5	17.6	2.2
LOS	C	B	A

Formulas and Reference Material

$$f_{HV} = \frac{1}{1 + P_T(E_T-1)+P_R(E_R-1)}$$ HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P}$$ HCM 2010, Equation 11-2

$$D_{MD} = \frac{0.0175*v_f}{N}$$ HCM 2010, Equation 13-26

Basic Freeway Segments Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
75	2,400
70	2,400
65	2,350
60	2,300
55	2,250

Source: HCM 2010, Exhibit 11-17

Ramp Roadways Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

Diverge LOS Thresholds

LOS	Density (pc/mi/ln)
A	≤10
B	>10-20
C	>20-28
D	>28-35
E	>35
F	v/c > 1

Source: HCM 2010, Exhibit 13-2

FREEWAY RAMP ADD OR DROP LANE ANALYSIS

ATKINS

General Information

Date Performed:	7/25/2014	Freeway/Direction	I-26 EB
Analysis Year	2038 No Action	Junction	EB On from Cypress St
Analysis Time Period:	PM Peak	Segment ID	1270
Project Description:	Navy Base ICTF		

Inputs

	Freeway Upstream of Ramp	Freeway Downstream of Ramp	Ramp
Number of Lanes, N	2	3	1
Free-Flow Speed, FFS (mph)	55	55	45
Volume, V (veh/h)	2,149	2,328	179
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	5%	4%	8%
%RVs, P_R	0%	0%	0%

Performance Measures

	Freeway Upstream Ramp	Freeway Downstream Ramp	Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.98	0.98	0.96
Demand Flow Rate, v_p (pc/h/ln)	1,224	879	207
Capacity Flow Rate, c (pc/h/ln)	2,250	2,250	2,100
v/c ratio	0.54	0.39	0.10
Density, D_{MD} (pc/mi/ln)	21.4	15.4	3.6
LOS	C	B	A

Formulas and Reference Material

$$f_{HV} = \frac{1}{1 + P_T(E_T-1)+P_R(E_R-1)}$$ HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P}$$ HCM 2010, Equation 11-2

$$D_{MD} = \frac{0.0175*v_f}{N}$$ HCM 2010, Equation 13-26

Basic Freeway Segments Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
75	2,400
70	2,400
65	2,350
60	2,300
55	2,250

Source: HCM 2010, Exhibit 11-17

Ramp Roadways Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

Diverge LOS Thresholds

LOS	Density (pc/mi/ln)
A	≤10
B	>10-20
C	>20-28
D	>28-35
E	>35
F	v/c > 1

Source: HCM 2010, Exhibit 13-2

BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-26 EB*
Agency or Company	*Atkins*	From/To	*1280 - East Of Cypress*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2038 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*2651*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*5*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.976*

Speed Inputs			Calc Speed Adj and FFS		
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f_{LW}		mph
Number of Lanes, N	*3*		f_{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	*55.0*	mph	FFS	*55.0*	mph
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures			Design (N)	
Operational (LOS)			Design (N)	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1006*	pc/h/ln	Design LOS	
S	*55.0*	mph	v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h/ln
D = v_p / S	*18.3*	pc/mi/ln	S	mph
LOS	*C*		D = v_p / S	pc/mi/ln
			Required Number of Lanes, N	

Glossary		Factor Location	
N - Number of lanes	S - Speed	E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
V - Hourly volume	D - Density	E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 11-18	TRD - Page 11-11
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 11-2, 11-3	
DDHV - Directional design hour volume			

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F-3252

BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-26 EB*
Agency or Company	*Atkins*	From/To	*1280 - East Of Cypress*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*PM Peak*	Analysis Year	*2038 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*2328*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*4*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.980*

Speed Inputs			Calc Speed Adj and FFS		
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f_{LW}		mph
Number of Lanes, N	*3*		f_{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	*55.0*	mph	FFS	*55.0*	mph
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures			Design (N)	
Operational (LOS)			Design (N)	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*879*	pc/h/ln	Design LOS	
S	*55.0*	mph	v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h/ln
D = v_p / S	*16.0*	pc/mi/ln	S	mph
LOS	*B*		D = v_p / S	pc/mi/ln
			Required Number of Lanes, N	

Glossary		Factor Location	
N - Number of lanes	S - Speed	E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
V - Hourly volume	D - Density	E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 11-18	TRD - Page 11-11
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 11-2, 11-3	
DDHV - Directional design hour volume			

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F-3253

FREEWAY RAMP ADD OR DROP LANE ANALYSIS

ATKINS

General Information

Date Performed:	7/25/2014	Freeway/Direction	I-26 WB
Analysis Year	2038 No Action	Junction	WB Off to US-17 NB
Analysis Time Period:	AM Peak	Segment ID	2010
Project Description:	Navy Base ICTF		

Inputs

	Freeway Upstream of Ramp	Freeway Downstream of Ramp	Ramp
Number of Lanes, N	4	3	2
Free-Flow Speed, FFS (mph)	55	55	55
Volume, V (veh/h)	3,396	1,360	2,036
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	5%	6%	4%
%RVs, P_R	0%	0%	0%

Performance Measures

	Freeway Upstream Ramp	Freeway Downstream Ramp	Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.98	0.97	0.98
Demand Flow Rate, v_p (pc/h/ln)	967	519	1,154
Capacity Flow Rate, c (pc/h/ln)	2,250	2,250	2,200
v/c ratio	0.43	0.23	0.52
Density, D_{MD} (pc/mi/ln)	16.9	9.1	20.2
LOS	B	A	C

Formulas and Reference Material

$$f_{HV} = \frac{1}{1 + P_T(E_T-1)+P_R(E_R-1)}$$

HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P}$$

HCM 2010, Equation 11-2

$$D_{MD} = \frac{0.0175*v_f}{N}$$

HCM 2010, Equation 13-26

Basic Freeway Segments Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
75	2,400
70	2,400
65	2,350
60	2,300
55	2,250

Source: HCM 2010, Exhibit 11-17

Ramp Roadways Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

Diverge LOS Thresholds

LOS	Density (pc/mi/ln)
A	≤10
B	>10-20
C	>20-28
D	>28-35
E	>35
F	v/c > 1

Source: HCM 2010, Exhibit 13-2

FREEWAY RAMP ADD OR DROP LANE ANALYSIS

ATKINS

General Information

Date Performed:	7/25/2014	Freeway/Direction	I-26 WB
Analysis Year	2038 No Action	Junction	WB Off to US-17 NB
Analysis Time Period:	PM Peak	Segment ID	2010
Project Description:	Navy Base ICTF		

Inputs

	Freeway Upstream of Ramp	Freeway Downstream of Ramp	Ramp
Number of Lanes, N	4	3	2
Free-Flow Speed, FFS (mph)	55	55	55
Volume, V (veh/h)	4,404	2,089	2,315
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	4%	4%	3%
%RVs, P_R	0%	0%	0%

Performance Measures

	Freeway Upstream Ramp	Freeway Downstream Ramp	Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.98	0.98	0.99
Demand Flow Rate, v_p (pc/h/ln)	1,248	789	1,305
Capacity Flow Rate, c (pc/h/ln)	2,250	2,250	2,200
v/c ratio	0.55	0.35	0.59
Density, D_{MD} (pc/mi/ln)	21.8	13.8	22.8
LOS	C	B	C

Formulas and Reference Material

$$f_{HV} = \frac{1}{1 + P_T(E_T-1)+P_R(E_R-1)}$$

HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P}$$

HCM 2010, Equation 11-2

$$D_{MD} = \frac{0.0175*v_f}{N}$$

HCM 2010, Equation 13-26

Basic Freeway Segments Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
75	2,400
70	2,400
65	2,350
60	2,300
55	2,250

Source: HCM 2010, Exhibit 11-17

Ramp Roadways Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

Diverge LOS Thresholds

LOS	Density (pc/mi/ln)
A	≤10
B	>10-20
C	>20-28
D	>28-35
E	>35
F	v/c > 1

Source: HCM 2010, Exhibit 13-2

FREEWAY RAMP ADD OR DROP LANE ANALYSIS

ATKINS

General Information

Date Performed:	3/20/2014	Freeway/Direction	I-26 WB
Analysis Year	2038 No Action	Junction	WB Off to Romney St
Analysis Time Period:	AM Peak	Segment ID	2020
Project Description:	Navy Base ICTF		

Inputs

	Freeway Upstream of Ramp	Freeway Downstream of Ramp	Ramp
Number of Lanes, N	3	2	1
Free-Flow Speed, FFS (mph)	55	55	45
Volume, V (veh/h)	1,360	1,130	230
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	6%	6%	5%
%RVs, P_R	0%	0%	0%

Performance Measures

	Freeway Upstream Ramp	Freeway Downstream Ramp	Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.97	0.97	0.98
Demand Flow Rate, v_p (pc/h/ln)	519	647	262
Capacity Flow Rate, c (pc/h/ln)	2,250	2,250	2,100
v/c ratio	0.23	0.29	0.12
Density, D_{MD} (pc/mi/ln)	9.1	11.3	4.6
LOS	A	B	A

Formulas and Reference Material

$$f_{HV} = \frac{1}{1 + P_T(E_T-1)+P_R(E_R-1)}$$ HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P}$$ HCM 2010, Equation 11-2

$$D_{MD} = \frac{0.0175*v_f}{N}$$ HCM 2010, Equation 13-26

Basic Freeway Segments Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
75	2,400
70	2,400
65	2,350
60	2,300
55	2,250

Source: HCM 2010, Exhibit 11-17

Ramp Roadways Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

Diverge LOS Thresholds

LOS	Density (pc/mi/ln)
A	≤10
B	>10-20
C	>20-28
D	>28-35
E	>35
F	v/c > 1

Source: HCM 2010, Exhibit 13-2

FREEWAY RAMP ADD OR DROP LANE ANALYSIS

ATKINS

General Information

Date Performed:	7/25/2014	Freeway/Direction	I-26 WB
Analysis Year	2038 No Action	Junction	WB Off to Romney St
Analysis Time Period:	PM Peak	Segment ID	2020
Project Description:	Navy Base ICTF		

Inputs

	Freeway Upstream of Ramp	Freeway Downstream of Ramp	Ramp
Number of Lanes, N	3	2	1
Free-Flow Speed, FFS (mph)	55	55	45
Volume, V (veh/h)	2,089	1,938	151
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	4%	4%	7%
%RVs, P_R	0%	0%	0%

Performance Measures

	Freeway Upstream Ramp	Freeway Downstream Ramp	Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.98	0.98	0.97
Demand Flow Rate, v_p (pc/h/ln)	789	1,098	174
Capacity Flow Rate, c (pc/h/ln)	2,250	2,250	2,100
v/c ratio	0.35	0.49	0.08
Density, D_{MD} (pc/mi/ln)	13.8	19.2	3.0
LOS	B	B	A

Formulas and Reference Material

$$f_{HV} = \frac{1}{1 + P_T(E_T-1)+P_R(E_R-1)}$$ HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P}$$ HCM 2010, Equation 11-2

$$D_{MD} = \frac{0.0175*v_f}{N}$$ HCM 2010, Equation 13-26

Basic Freeway Segments Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
75	2,400
70	2,400
65	2,350
60	2,300
55	2,250

Source: HCM 2010, Exhibit 11-17

Ramp Roadways Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

Diverge LOS Thresholds

LOS	Density (pc/mi/ln)
A	≤10
B	>10-20
C	>20-28
D	>28-35
E	>35
F	v/c > 1

Source: HCM 2010, Exhibit 13-2

BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-26 WB*
Agency or Company	*Atkins*	From/To	*2025- Romney Off to US17 SB On*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2038 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*1130*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*6*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.971*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*55.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*55.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*647*	pc/h/ln
S	*55.0*	mph
D = v_p / S	*11.8*	pc/mi/ln
LOS	*B*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-26 WB*
Agency or Company	*Atkins*	From/To	*2025- Romney Off to US17 SB On*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*PM Peak*	Analysis Year	*2038 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*1938*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*4*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.980*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*55.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*55.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1098*	pc/h/ln
S	*55.0*	mph
D = v_p / S	*20.0*	pc/mi/ln
LOS	*C*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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FREEWAY RAMP ADD OR DROP LANE ANALYSIS

ATKINS

General Information

Date Performed:	7/25/2014	Freeway/Direction	I-26 WB
Analysis Year	2038 No Action	Junction	WB On from US-17 SB
Analysis Time Period:	AM Peak	Segment ID	2030
Project Description:	Navy Base ICTF		

Inputs

	Freeway Upstream of Ramp	Freeway Downstream of Ramp	Ramp
Number of Lanes, N	2	3	1
Free-Flow Speed, FFS (mph)	55	55	55
Volume, V (veh/h)	1,130	2,422	1,292
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	6%	5%	5%
%RVs, P_R	0%	0%	0%

Performance Measures

	Freeway Upstream Ramp	Freeway Downstream Ramp	Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.97	0.98	0.98
Demand Flow Rate, v_p (pc/h/ln)	647	919	1,471
Capacity Flow Rate, c (pc/h/ln)	2,250	2,250	2,200
v/c ratio	0.29	0.41	0.67
Density, D_{MD} (pc/mi/ln)	11.3	16.1	25.7
LOS	B	B	C

Formulas and Reference Material

$$f_{HV} = \frac{1}{1 + P_T(E_T-1)+P_R(E_R-1)}$$ HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P}$$ HCM 2010, Equation 11-2

$$D_{MD} = \frac{0.0175*v_f}{N}$$ HCM 2010, Equation 13-26

Basic Freeway Segments Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
75	2,400
70	2,400
65	2,350
60	2,300
55	2,250

Source: HCM 2010, Exhibit 11-17

Ramp Roadways Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

Diverge LOS Thresholds

LOS	Density (pc/mi/ln)
A	≤10
B	>10-20
C	>20-28
D	>28-35
E	>35
F	v/c > 1

Source: HCM 2010, Exhibit 13-2

FREEWAY RAMP ADD OR DROP LANE ANALYSIS

ATKINS

General Information

Date Performed:	7/25/2014	Freeway/Direction	I-26 WB
Analysis Year	2038 No Action	Junction	WB On from US-17 SB
Analysis Time Period:	PM Peak	Segment ID	2030
Project Description:	Navy Base ICTF		

Inputs

	Freeway Upstream of Ramp	Freeway Downstream of Ramp	Ramp
Number of Lanes, N	2	3	1
Free-Flow Speed, FFS (mph)	55	55	55
Volume, V (veh/h)	1,938	3,233	1,295
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	4%	4%	4%
%RVs, P_R	0%	0%	0%

Performance Measures

	Freeway Upstream Ramp	Freeway Downstream Ramp	Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.98	0.98	0.98
Demand Flow Rate, v_p (pc/h/ln)	1,098	1,221	1,468
Capacity Flow Rate, c (pc/h/ln)	2,250	2,250	2,200
v/c ratio	0.49	0.54	0.67
Density, D_{MD} (pc/mi/ln)	19.2	21.4	25.7
LOS	B	C	C

Formulas and Reference Material

$$f_{HV} = \frac{1}{1 + P_T(E_T-1)+P_R(E_R-1)}$$ HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P}$$ HCM 2010, Equation 11-2

$$D_{MD} = \frac{0.0175*v_f}{N}$$ HCM 2010, Equation 13-26

Basic Freeway Segments Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
75	2,400
70	2,400
65	2,350
60	2,300
55	2,250

Source: HCM 2010, Exhibit 11-17

Ramp Roadways Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

Diverge LOS Thresholds

LOS	Density (pc/mi/ln)
A	≤10
B	>10-20
C	>20-28
D	>28-35
E	>35
F	v/c > 1

Source: HCM 2010, Exhibit 13-2

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-26 WB
Agency or Company	Atkins	Junction	2040 - WB On from Meeting
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2038 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Number of Lanes, N: 3	☐ Yes ☐ On
☑ No ☐ Off	Acceleration Lane Length, L_A: 600	☑ No ☐ Off
L_{up} = ft	Deceleration Lane Length L_D:	L_{down} = ft
V_u = veh/h	Freeway Volume, V_F: 2422	V_D = veh/h
	Ramp Volume, V_R: 378	
	Freeway Free-Flow Speed, S_{FF}: 55.0	
	Ramp Free-Flow Speed, S_{FR}: 45.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	2422	0.90	Level	5	0	0.976	1.00	2758
Ramp	378	0.90	Level	10	0	0.952	1.00	441
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 0.594 using Equation (Exhibit 13-6)

V_{12} = 1639 pc/h

V_3 or V_{av34} 1119 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	3199	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	2080	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = 17.7 (pc/mi/ln)

LOS = B (Exhibit 13-2)

Speed Determination

M_S = 0.298 (Exibit 13-11)

S_R= 51.1 mph (Exhibit 13-11)

S_0= 52.8 mph (Exhibit 13-11)

S = 51.7 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-26 WB
Agency or Company	Atkins	Junction	2040 - WB On from Meeting
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2038 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Number of Lanes, N: 3	☐ Yes ☐ On
☑ No ☐ Off	Acceleration Lane Length, L_A: 600	☑ No ☐ Off
L_{up} = ft	Deceleration Lane Length L_D:	L_{down} = ft
V_u = veh/h	Freeway Volume, V_F: 3233	V_D = veh/h
	Ramp Volume, V_R: 750	
	Freeway Free-Flow Speed, S_{FF}: 55.0	
	Ramp Free-Flow Speed, S_{FR}: 45.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	3233	0.90	Level	4	0	0.980	1.00	3664
Ramp	750	0.90	Level	4	0	0.980	1.00	850
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 0.594 using Equation (Exhibit 13-6)

V_{12} = 2178 pc/h

V_3 or V_{av34} 1486 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * $V_{12}/2$ ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	4514	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	3028	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = 24.9 (pc/mi/ln)

LOS = C (Exhibit 13-2)

Speed Determination

M_S = 0.348 (Exibit 13-11)

S_R= 50.5 mph (Exhibit 13-11)

S_0= 51.5 mph (Exhibit 13-11)

S = 50.8 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * $V_{12}/2$ ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-26 WB*
Agency or Company	*Atkins*	From/To	*2050 - Meeting to Mt Pleasant*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2038 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*2800*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*5*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.976*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*3*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*55.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*55.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1063*	pc/h/ln
S	*55.0*	mph
D = v_p / S	*19.3*	pc/mi/ln
LOS	*C*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-26 WB*
Agency or Company	*Atkins*	From/To	*2050 - Meeting to Mt Pleasant*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*PM Peak*	Analysis Year	*2038 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*3983*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*4*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.980*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*3*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*55.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*55.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1505*	pc/h/ln
S	*55.0*	mph
D = v_p / S	*27.4*	pc/mi/ln
LOS	*D*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-26 WB
Agency or Company	Atkins	Junction	2060 - WB On from Mt Pleasant
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2038 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Number of Lanes, N: 3	☐ Yes ☐ On
☑ No ☐ Off	Acceleration Lane Length, L_A: 275	☑ No ☐ Off
L_{up} = ft	Deceleration Lane Length L_D:	L_{down} = ft
V_u = veh/h	Freeway Volume, V_F: 2800	V_D = veh/h
	Ramp Volume, V_R: 337	
	Freeway Free-Flow Speed, S_{FF}: 55.0	
	Ramp Free-Flow Speed, S_{FR}: 45.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	2800	0.90	Level	5	0	0.976	1.00	3189
Ramp	337	0.90	Level	10	0	0.952	1.00	393
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 0.585 using Equation (Exhibit 13-6)

V_{12} = 1866 pc/h

V_3 or V_{av34} 1323 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	3582	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	2259	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = 21.2 (pc/mi/ln)

LOS = C (Exhibit 13-2)

Speed Determination

M_S = 0.334 (Exibit 13-11)

S_R= 50.7 mph (Exhibit 13-11)

S_0= 52.0 mph (Exhibit 13-11)

S = 51.2 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-26 WB
Agency or Company	Atkins	Junction	2060 - WB On from Mt Pleasant
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2038 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Number of Lanes, N: 3	☐ Yes ☐ On
☑ No ☐ Off	Acceleration Lane Length, L_A: 275	☑ No ☐ Off
L_{up} = ft	Deceleration Lane Length L_D:	L_{down} = ft
V_u = veh/h	Freeway Volume, V_F: 3983	V_D = veh/h
	Ramp Volume, V_R: 805	
	Freeway Free-Flow Speed, S_{FF}: 55.0	
	Ramp Free-Flow Speed, S_{FR}: 45.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	3983	0.90	Level	4	0	0.980	1.00	4514
Ramp	805	0.90	Level	3	0	0.985	1.00	908
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 0.585 using Equation (Exhibit 13-6)

V_{12} = 2642 pc/h

V_3 or V_{av34} 1872 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	5422	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	3550	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = 31.0 (pc/mi/ln)

LOS = D (Exhibit 13-2)

Speed Determination

M_S = 0.432 (Exibit 13-11)

S_R= 49.4 mph (Exhibit 13-11)

S_0= 50.1 mph (Exhibit 13-11)

S = 49.6 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-26 WB
Agency or Company	Atkins	Junction	2070 - WB On from Heriot
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2038 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Number of Lanes, N: 3	☐ Yes ☐ On
☑ No ☐ Off	Acceleration Lane Length, L_A: 1165	☑ No ☐ Off
L_{up} = ft	Deceleration Lane Length L_D:	L_{down} = ft
V_u = veh/h	Freeway Volume, V_F: 3137	V_D = veh/h
	Ramp Volume, V_R: 279	
	Freeway Free-Flow Speed, S_{FF}: 55.0	
	Ramp Free-Flow Speed, S_{FR}: 45.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	3137	0.90	Level	6	0	0.971	1.00	3590
Ramp	279	0.90	Level	22	0	0.901	1.00	344
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 0.610 using Equation (Exhibit 13-6)

V_{12} = 2190 pc/h

V_3 or V_{av34} 1400 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	3934	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	2534	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = 17.8 (pc/mi/ln)

LOS = B (Exhibit 13-2)

Speed Determination

M_S = 0.265 (Exibit 13-11)

S_R= 51.6 mph (Exhibit 13-11)

S_0= 51.8 mph (Exhibit 13-11)

S = 51.6 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-26 WB
Agency or Company	Atkins	Junction	2070 - WB On from Heriot
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2038 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Number of Lanes, N: 3	☐ Yes ☐ On
☑ No ☐ Off	Acceleration Lane Length, L_A: 1165	☑ No ☐ Off
L_{up} = ft	Deceleration Lane Length L_D:	L_{down} = ft
V_u = veh/h	Freeway Volume, V_F: 4788	V_D = veh/h
	Ramp Volume, V_R: 467	
	Freeway Free-Flow Speed, S_{FF}: 55.0	
	Ramp Free-Flow Speed, S_{FR}: 45.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	4788	0.90	Level	5	0	0.976	1.00	5453
Ramp	467	0.90	Level	11	0	0.948	1.00	547
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 0.610 using Equation (Exhibit 13-6)

V_{12} = 3327 pc/h

V_3 or V_{av34} 2126 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	6000	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	3874	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = 28.1 (pc/mi/ln)

LOS = D (Exhibit 13-2)

Speed Determination

M_S = 0.404 (Exibit 13-11)

S_R= 49.7 mph (Exhibit 13-11)

S_0= 49.1 mph (Exhibit 13-11)

S = 49.5 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-26 WB*
Agency or Company	*Atkins*	From/To	*2080 - Heriot to PAR*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2038 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*3416*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*6*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.971*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*3*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*60.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*60.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1303*	pc/h/ln
S	*60.0*	mph
D = v_p / S	*21.7*	pc/mi/ln
LOS	*C*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-26 WB*
Agency or Company	*Atkins*	From/To	*2080 - Heriot to PAR*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*PM Peak*	Analysis Year	*2038 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*5255*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*5*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.976*

Speed Inputs			Calc Speed Adj and FFS		
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f_{LW}		mph
Number of Lanes, N	*3*		f_{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	*60.0*	mph	FFS	*60.0*	mph
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures			Design (N)	
Operational (LOS)			Design (N)	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1995*	pc/h/ln	Design LOS	
			v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h/ln
S	*57.2*	mph	S	mph
D = v_p / S	*34.9*	pc/mi/ln	D = v_p / S	pc/mi/ln
LOS	*D*		Required Number of Lanes, N	

Glossary		Factor Location	
N - Number of lanes	S - Speed	E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
V - Hourly volume	D - Density	E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 11-18	TRD - Page 11-11
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 11-2, 11-3	
DDHV - Directional design hour volume			

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-26 WB
Agency or Company	Atkins	Junction	2090-WB Off to PAR
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2038 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Number of Lanes, N: 3	☐ Yes ☐ On
☑ No ☐ Off	Acceleration Lane Length, L_A:	☑ No ☐ Off
L_{up} = ft	Deceleration Lane Length L_D: 340	L_{down} = ft
V_u = veh/h	Freeway Volume, V_F: 3416	V_D = veh/h
	Ramp Volume, V_R: 585	
	Freeway Free-Flow Speed, S_{FF}: 60.0	
	Ramp Free-Flow Speed, S_{FR}: 45.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	3416	0.90	Level	6	0	0.971	1.00	3909
Ramp	585	0.90	Level	43	0	0.823	1.00	790
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 0.626 using Equation (Exhibit 13-7)

V_{12} = 2742 pc/h

V_3 or V_{av34} 1167 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	3909	Exhibit 13-8	6900	No
$V_{FO} = V_F - V_R$	3119	Exhibit 13-8	6900	No
V_R	790	Exhibit 13-10	2100	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	2742	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = 24.8 (pc/mi/ln)

LOS = C (Exhibit 13-2)

Speed Determination

D_s = 0.369 (Exhibit 13-12)

S_R= 53.4 mph (Exhibit 13-12)

S_0= 65.2 mph (Exhibit 13-12)

S = 56.4 mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-26 WB
Agency or Company	Atkins	Junction	2090-WB Off to PAR
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2038 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Number of Lanes, N: 3	☐ Yes ☐ On
☑ No ☐ Off	Acceleration Lane Length, L_A	☑ No ☐ Off
L_{up} = ft	Deceleration Lane Length L_D: 340	L_{down} = ft
V_u = veh/h	Freeway Volume, V_F: 5255	V_D = veh/h
	Ramp Volume, V_R: 295	
	Freeway Free-Flow Speed, S_{FF}: 60.0	
	Ramp Free-Flow Speed, S_{FR}: 45.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	5255	0.90	Level	5	0	0.976	1.00	5985
Ramp	295	0.90	Level	38	0	0.840	1.00	390
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 0.592 using Equation (Exhibit 13-7)

V_{12} = 3705 pc/h

V_3 or V_{av34} 2280 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	5985	Exhibit 13-8	6900	No
$V_{FO} = V_F - V_R$	5595	Exhibit 13-8	6900	No
V_R	390	Exhibit 13-10	2100	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	3705	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = 33.1 (pc/mi/ln)

LOS = D (Exhibit 13-2)

Speed Determination

D_s = 0.333 (Exhibit 13-12)

S_R= 54.0 mph (Exhibit 13-12)

S_0= 60.8 mph (Exhibit 13-12)

S = 56.4 mph (Exhibit 13-13)

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-26 WB*
Agency or Company	*Atkins*	From/To	*2100 - PAR Off to PAR On*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2038 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*2831*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*8*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.962*

Speed Inputs			Calc Speed Adj and FFS		
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f_{LW}		mph
Number of Lanes, N	*3*		f_{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	*60.0*	mph	FFS	*60.0*	mph
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures			Design (N)	
Operational (LOS)			Design (N)	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1090*	pc/h/ln	Design LOS	
			v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h/ln
S	*60.0*	mph	S	mph
D = v_p / S	*18.2*	pc/mi/ln	D = v_p / S	pc/mi/ln
LOS	*C*		Required Number of Lanes, N	

Glossary		Factor Location	
N - Number of lanes	S - Speed	E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
V - Hourly volume	D - Density	E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 11-18	TRD - Page 11-11
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 11-2, 11-3	
DDHV - Directional design hour volume			

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-26 WB*
Agency or Company	*Atkins*	From/To	*2100 - PAR Off to PAR On*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*PM Peak*	Analysis Year	*2038 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*4960*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*7*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.966*

Speed Inputs			Calc Speed Adj and FFS		
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f_{LW}		mph
Number of Lanes, N	*3*		f_{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	*60.0*	mph	FFS	*60.0*	mph
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures			Design (N)	
Operational (LOS)			Design (N)	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1901*	pc/h/ln	Design LOS	
			v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h/ln
S	*58.4*	mph	S	mph
D = v_p / S	*32.6*	pc/mi/ln	D = v_p / S	pc/mi/ln
LOS	*D*		Required Number of Lanes, N	

Glossary		Factor Location	
N - Number of lanes	S - Speed	E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
V - Hourly volume	D - Density	E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 11-18	TRD - Page 11-11
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 11-2, 11-3	
DDHV - Directional design hour volume			

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RAMP ADD OR DROP LANE ANALYSIS (MAINLINE <55 MPH)

ATKINS

General Information

Date Performed:	3/20/2014	Freeway/Direction	WB US-52 & PAR Off Ramp
Analysis Year	2038 No Action	Junction	US-52 & PAR WB Ramp Merge
Analysis Time Period:	AM Peak	Segment ID	2105
Project Description:	Navy Base ICTF		

Inputs

	Mainline Upstream Ramp	Mainline Downstream Ramp	Ramp
Number of Lanes, N	1	1	1
Free-Flow Speed, FFS (mph)	55	55	45
Volume, V (veh/h)	1,140	1,250	110
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	4%	8%	43%
%RVs, P_R	0%	0%	0%

Performance Measures

	Upstream of Off-Ramp	Downstream of Off-Ramp	Off-Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.98	0.96	0.82
Demand Flow Rate, v_p (pc/h/ln)	1,292	1,444	149
Capacity Flow Rate, c (pc/h/ln)	2,200	2,200	2,100
v/c ratio	0.59	0.66	0.07
Density, D_{MD} (pc/mi/ln)	22.6	25.3	2.6
LOS	C	C	A

Formulas and Reference Material

$$f_{HV} = \frac{1}{1+P_T(E_T-1)+P_R(E_R-1)}$$ HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P}$$ HCM 2010, Equation 11-2

$$D_{MD} = \frac{0.0175*v_f}{N}$$ HCM 2010, Equation 13-26

Ramp Roadways Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

Diverge LOS Thresholds

LOS	Density (pc/mi/ln)
A	≤10
B	>10-20
C	>20-28
D	>28-35
E	>35
F	v/c > 1

Source: HCM 2010, Exhibit 13-2

RAMP ADD OR DROP LANE ANALYSIS (MAINLINE <55 MPH)

ATKINS

General Information

Date Performed:	3/20/2014	Freeway/Direction	WB US-52 & PAR Off Ramp
Analysis Year	2038 No Action	Junction	US-52 & PAR WB Ramp Merge
Analysis Time Period:	PM Peak	Segment ID	2105
Project Description:	Navy Base ICTF		

Inputs

	Mainline Upstream Ramp	Mainline Downstream Ramp	Ramp
Number of Lanes, N	1	1	1
Free-Flow Speed, FFS (mph)	55	55	45
Volume, V (veh/h)	406	706	300
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	10%	22%	38%
%RVs, P_R	0%	0%	0%

Performance Measures

	Upstream of Off-Ramp	Downstream of Off-Ramp	Off-Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.95	0.90	0.84
Demand Flow Rate, v_p (pc/h/ln)	474	871	397
Capacity Flow Rate, c (pc/h/ln)	2,200	2,200	2,100
v/c ratio	0.22	0.40	0.19
Density, D_{MD} (pc/mi/ln)	8.3	15.2	6.9
LOS	A	B	A

Formulas and Reference Material

$$f_{HV} = \frac{1}{1+P_T(E_T-1)+P_R(E_R-1)}$$ HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P}$$ HCM 2010, Equation 11-2

$$D_{MD} = \frac{0.0175*v_f}{N}$$ HCM 2010, Equation 13-26

Ramp Roadways Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

Diverge LOS Thresholds

LOS	Density (pc/mi/ln)
A	≤10
B	>10-20
C	>20-28
D	>28-35
E	>35
F	v/c > 1

Source: HCM 2010, Exhibit 13-2

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-26 WB
Agency or Company	Atkins	Junction	2110 - WB On from US-52 & PAR
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2038 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Number of Lanes, N: 3	☐ Yes ☐ On
☑ No ☐ Off	Acceleration Lane Length, L_A: 180	☑ No ☐ Off
L_{up} = ft	Deceleration Lane Length L_D:	L_{down} = ft
V_u = veh/h	Freeway Volume, V_F: 2831	V_D = veh/h
	Ramp Volume, V_R: 1250	
	Freeway Free-Flow Speed, S_{FF}: 60.0	
	Ramp Free-Flow Speed, S_{FR}: 45.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	2831	0.90	Level	8	0	0.962	1.00	3271
Ramp	1250	0.90	Level	8	0	0.962	1.00	1444
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 0.583 using Equation (Exhibit 13-6)

V_{12} = 1905 pc/h

V_3 or V_{av34} 1366 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * $V_{12}/2$ ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	4715	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	3349	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = 29.8 (pc/mi/ln)

LOS = D (Exhibit 13-2)

Speed Determination

M_S = 0.416 (Exibit 13-11)

S_R= 52.5 mph (Exhibit 13-11)

S_0= 56.9 mph (Exhibit 13-11)

S = 53.7 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * $V_{12}/2$ ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-26 WB
Agency or Company	Atkins	Junction	2110 - WB On from US-52 & PAR
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2038 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Number of Lanes, N: 3	☐ Yes ☐ On
☑ No ☐ Off	Acceleration Lane Length, L_A: 180	☑ No ☐ Off
L_{up} = ft	Deceleration Lane Length L_D:	L_{down} = ft
V_u = veh/h	Freeway Volume, V_F: 4960	V_D = veh/h
	Ramp Volume, V_R: 706	
	Freeway Free-Flow Speed, S_{FF}: 60.0	
	Ramp Free-Flow Speed, S_{FR}: 45.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	4960	0.90	Level	7	0	0.966	1.00	5704
Ramp	706	0.90	Level	22	0	0.901	1.00	871
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 0.583 using Equation (Exhibit 13-6)

V_{12} = 3323 pc/h

V_3 or V_{av34} 2381 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	6575	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	4194	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = 36.7 (pc/mi/ln)

LOS = E (Exhibit 13-2)

Speed Determination

M_S = 0.563 (Exibit 13-11)

S_R= 49.9 mph (Exhibit 13-11)

S_0= 53.0 mph (Exhibit 13-11)

S = 50.9 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-26 WB*
Agency or Company	*Atkins*	From/To	*2120 - US-52 to Cosgrove*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2038 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*4081*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*8*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.962*

Speed Inputs			Calc Speed Adj and FFS		
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f_{LW}		mph
Number of Lanes, N	*3*		f_{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	*60.0*	mph	FFS	*60.0*	mph
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures			Design (N)	
Operational (LOS)			Design (N)	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1572*	pc/h/ln	Design LOS	
			v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h/ln
S	*60.0*	mph	S	mph
D = v_p / S	*26.2*	pc/mi/ln	D = v_p / S	pc/mi/ln
LOS	*D*		Required Number of Lanes, N	

Glossary		Factor Location	
N - Number of lanes	S - Speed	E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
V - Hourly volume	D - Density	E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 11-18	TRD - Page 11-11
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 11-2, 11-3	
DDHV - Directional design hour volume			

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-26 WB*
Agency or Company	*Atkins*	From/To	*2120 - US-52 to Cosgrove*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*PM Peak*	Analysis Year	*2038 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*5666*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*7*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.966*

Speed Inputs			Calc Speed Adj and FFS		
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f_{LW}		mph
Number of Lanes, N	*3*		f_{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	*60.0*	mph	FFS	*60.0*	mph
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures			Design (N)	
Operational (LOS)			Design (N)	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*2172*	pc/h/ln	Design LOS	
			v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h/ln
S	*54.1*	mph	S	mph
D = v_p / S	*40.2*	pc/mi/ln	D = v_p / S	pc/mi/ln
LOS	*E*		Required Number of Lanes, N	

Glossary		Factor Location	
N - Number of lanes	S - Speed	E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
V - Hourly volume	D - Density	E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 11-18	TRD - Page 11-11
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 11-2, 11-3	
DDHV - Directional design hour volume			

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-26 WB
Agency or Company	Atkins	Junction	2130-WB Off to Cosgrove NB
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2038 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Number of Lanes, N	3	Downstream Adj Ramp	
☐ Yes	☐ On	Acceleration Lane Length, L_A		☐ Yes	☐ On
☑ No	☐ Off	Deceleration Lane Length L_D	525	☑ No	☐ Off
L_{up} =	ft	Freeway Volume, V_F	4081	L_{down} =	ft
V_u =	veh/h	Ramp Volume, V_R	459	V_D =	veh/h
		Freeway Free-Flow Speed, S_{FF}	60.0		
		Ramp Free-Flow Speed, S_{FR}	45.0		

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	4081	0.90	Level	8	0	0.962	1.00	4716
Ramp	459	0.90	Level	13	0	0.939	1.00	543
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 0.617 using Equation (Exhibit 13-7)

V_{12} = 3118 pc/h

V_3 or V_{av34} 1598 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	4716	Exhibit 13-8	6900	No
$V_{FO} = V_F - V_R$	4173	Exhibit 13-8	6900	No
V_R	543	Exhibit 13-10	2100	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	3118	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = 26.3 (pc/mi/ln)

LOS = C (Exhibit 13-2)

Speed Determination

D_s = 0.347 (Exhibit 13-12)

S_R= 53.8 mph (Exhibit 13-12)

S_0= 63.5 mph (Exhibit 13-12)

S = 56.7 mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-26 WB
Agency or Company	Atkins	Junction	2130-WB Off to Cosgrove NB
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2038 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Number of Lanes, N	3	Downstream Adj Ramp	
☐ Yes	☐ On	Acceleration Lane Length, L_A		☐ Yes	☐ On
☑ No	☐ Off	Deceleration Lane Length L_D	525	☑ No	☐ Off
L_{up} =	ft	Freeway Volume, V_F	5666	L_{down} =	ft
V_u =	veh/h	Ramp Volume, V_R	419	V_D =	veh/h
		Freeway Free-Flow Speed, S_{FF}	60.0		
		Ramp Free-Flow Speed, S_{FR}	45.0		

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	5666	0.90	Level	7	0	0.966	1.00	6516
Ramp	419	0.90	Level	12	0	0.943	1.00	493
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 0.574 using Equation (Exhibit 13-7)

V_{12} = 3953 pc/h

V_3 or V_{av34} 2563 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	6516	Exhibit 13-8	6900	No
$V_{FO} = V_F - V_R$	6023	Exhibit 13-8	6900	No
V_R	493	Exhibit 13-10	2100	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	3953	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = 33.5 (pc/mi/ln)

LOS = D (Exhibit 13-2)

Speed Determination

D_s = 0.342 (Exhibit 13-12)

S_R= 53.8 mph (Exhibit 13-12)

S_0= 59.7 mph (Exhibit 13-12)

S = 56.0 mph (Exhibit 13-13)

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-26 WB*
Agency or Company	*Atkins*	From/To	*2135-Cosg NB Off to Cosg NB On*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2038 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*3622*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*8*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.962*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*3*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*60.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*60.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1395*	pc/h/ln
S	*60.0*	mph
D = v_p / S	*23.3*	pc/mi/ln
LOS	*C*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-26 WB*
Agency or Company	*Atkins*	From/To	*2135-Cosg NB Off to Cosg NB On*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*PM Peak*	Analysis Year	*2038 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*5247*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*7*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.966*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*3*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*60.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*60.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*2011*	pc/h/ln
S	*56.9*	mph
D = v_p / S	*35.3*	pc/mi/ln
LOS	*E*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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Navy Base ICTF

FREEWAY WEAVING WORKSHEET

General Information

Analyst	AJR
Agency/Company	Atkins
Date Performed	7/25/2014
Analysis Time Period	AM Peak

Site Information

Freeway/Dir of Travel	I-26 WB
Weaving Segment Location	2140 - Cosgrove NB to Cos. SB
Analysis Year	2038 No Action

Project Description *Navy Base ICTF*

Inputs

Weaving configuration	One-Sided
Weaving number of lanes, N	4
Weaving segment length, L_S	560ft
Freeway free-flow speed, FFS	60 mph
Segment type	Freeway
Freeway minimum speed, S_{MIN}	15
Freeway maximum capacity, C_{IFL}	2300
Terrain type	Level

Conversions to pc/h Under Base Conditions

	V (veh/h)	PHF	Truck (%)	RV (%)	E_T	E_R	f_{HV}	f_p	v (pc/h)
V_{FF}	3244	0.90	8	0	1.5	1.2	0.962	1.00	3749
V_{RF}	869	0.90	19	0	1.5	1.2	0.913	1.00	1057
V_{FR}	378	0.90	28	0	1.5	1.2	0.877	1.00	479
V_{RR}	0	0.90	0	0	1.5	1.2	1.000	1.00	0
V_{NW}	3749							V =	5285
V_W	1536								
VR	0.291								

Configuration Characteristics

Minimum maneuver lanes, N_{WL}	2 lc	Minimum weaving lane changes, LC_{MIN}	1536 lc/h
Interchange density, ID	1.0 int/mi	Weaving lane changes, LC_W	1711 lc/h
Minimum RF lane changes, LC_{RF}	1 lc/pc	Non-weaving lane changes, LC_{NW}	305 lc/h
Minimum FR lane changes, LC_{FR}	1 lc/pc	Total lane changes, LC_{ALL}	2016 lc/h
Minimum RR lane changes, LC_{RR}	lc/pc	Non-weaving vehicle index, I_{NW}	210

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment flow rate, v	5285 pc/h	Weaving intensity factor, W	0.621
Weaving segment capacity, c_w	7396 veh/h	Weaving segment speed, S	42.6 mph
Weaving segment v/c ratio	0.687	Average weaving speed, S_W	42.8 mph
Weaving segment density, D	31.0 pc/mi/ln	Average non-weaving speed, S_{NW}	42.6 mph
Level of Service, LOS	D	Maximum weaving length, L_{MAX}	5484 ft

Notes

a. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments".
b. For volumes that exceed the weaving segment capacity, the level of service is "F".

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Navy Base ICTF

FREEWAY WEAVING WORKSHEET

General Information

Analyst	AJR
Agency/Company	Atkins
Date Performed	7/25/2014
Analysis Time Period	PM Peak

Site Information

Freeway/Dir of Travel	I-26 WB
Weaving Segment Location	2140 - Cosgrove NB to Cos. SB
Analysis Year	2038 No Action

Project Description *Navy Base ICTF*

Inputs

Weaving configuration	One-Sided	Segment type	Freeway
Weaving number of lanes, N	4	Freeway minimum speed, S_{MIN}	15
Weaving segment length, L_S	560ft	Freeway maximum capacity, C_{IFL}	2300
Freeway free-flow speed, FFS	60 mph	Terrain type	Level

Conversions to pc/h Under Base Conditions

	V (veh/h)	PHF	Truck (%)	RV (%)	E_T	E_R	f_{HV}	f_p	v (pc/h)
V_{FF}	4394	0.90	7	0	1.5	1.2	0.966	1.00	5053
V_{RF}	790	0.90	18	0	1.5	1.2	0.917	1.00	957
V_{FR}	853	0.90	11	0	1.5	1.2	0.948	1.00	1000
V_{RR}	0	0.90	0	0	1.5	1.2	1.000	1.00	0
V_{NW}	5053							V =	7010
V_W	1957								
VR	0.279								

Configuration Characteristics

Minimum maneuver lanes, N_{WL}	2 lc	Minimum weaving lane changes, LC_{MIN}	1957 lc/h
Interchange density, ID	1.0 int/mi	Weaving lane changes, LC_W	2132 lc/h
Minimum RF lane changes, LC_{RF}	1 lc/pc	Non-weaving lane changes, LC_{NW}	574 lc/h
Minimum FR lane changes, LC_{FR}	1 lc/pc	Total lane changes, LC_{ALL}	2706 lc/h
Minimum RR lane changes, LC_{RR}	lc/pc	Non-weaving vehicle index, I_{NW}	283

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment flow rate, v	7010 pc/h	Weaving intensity factor, W	0.783
Weaving segment capacity, c_w	7471 veh/h	Weaving segment speed, S	38.2 mph
Weaving segment v/c ratio	0.907	Average weaving speed, S_W	40.2 mph
Weaving segment density, D	45.8 pc/mi/ln	Average non-weaving speed, S_{NW}	37.5 mph
Level of Service, LOS	E	Maximum weaving length, L_{MAX}	5362 ft

Notes

a. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments".
b. For volumes that exceed the weaving segment capacity, the level of service is "F".

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-26 WB*
Agency or Company	*Atkins*	From/To	*2145-Cosg SB Off to Cosg SB On*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2038 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*4113*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*8*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.962*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*3*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*60.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*60.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1584*	pc/h/ln
S	*60.0*	mph
D = v_p / S	*26.4*	pc/mi/ln
LOS	*D*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-26 WB*
Agency or Company	*Atkins*	From/To	*2145-Cosg SB Off to Cosg SB On*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*PM Peak*	Analysis Year	*2038 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*5184*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*7*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.966*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*3*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*60.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*60.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1987*	pc/h/ln
S	*57.3*	mph
D = v_p / S	*34.7*	pc/mi/ln
LOS	*D*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-26 WB
Agency or Company	Atkins	Junction	2150 - WB On from Cosgrove SB
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2038 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Freeway Number of Lanes, N: 3	☑ Yes ☐ On
☑ No ☐ Off	Ramp Number of Lanes, N: 1	☐ No ☑ Off
L_{up} = ft	Acceleration Lane Length, L_A: 425	L_{down} = 2390 ft
V_u = veh/h	Deceleration Lane Length L_D	V_D = 379 veh/h
	Freeway Volume, V_F: 4113	
	Ramp Volume, V_R: 167	
	Freeway Free-Flow Speed, S_{FF}: 60.0	
	Ramp Free-Flow Speed, S_{FR}: 45.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	4113	0.90	Level	8	0	0.962	1.00	4753
Ramp	167	0.90	Level	25	0	0.889	1.00	209
UpStream								
DownStream	379	0.90	Level	20	0	0.909	1.00	463

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = 2985.65 (Equation 13-6 or 13-7)

P_{FM} = 0.600 using Equation (Exhibit 13-6)

V_{12} = 2850 pc/h

V_3 or V_{av34} 1903 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * $V_{12}/2$ ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	4962	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	3059	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = 26.6 (pc/mi/ln)

LOS = C (Exhibit 13-2)

Speed Determination

M_S = 0.366 (Exibit 13-11)

S_R= 53.4 mph (Exhibit 13-11)

S_0= 54.9 mph (Exhibit 13-11)

S = 54.0 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * $V_{12}/2$ ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-26 WB
Agency or Company	Atkins	Junction	2150 - WB On from Cosgrove SB
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2038 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Freeway Number of Lanes, N: 3	☑ Yes ☐ On
☑ No ☐ Off	Ramp Number of Lanes, N: 1	☐ No ☑ Off
L_{up} = ft	Acceleration Lane Length, L_A: 425	L_{down} = 2390 ft
V_u = veh/h	Deceleration Lane Length L_D:	V_D = 456 veh/h
	Freeway Volume, V_F: 5184	
	Ramp Volume, V_R: 344	
	Freeway Free-Flow Speed, S_{FF}: 60.0	
	Ramp Free-Flow Speed, S_{FR}: 45.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	5184	0.90	Level	7	0	0.966	1.00	5962
Ramp	344	0.90	Level	10	0	0.952	1.00	401
UpStream								
DownStream	456	0.90	Level	14	0	0.935	1.00	542

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = 3495.08 (Equation 13-6 or 13-7)

P_{FM} = 0.608 using Equation (Exhibit 13-6)

V_{12} = 3627 pc/h

V_3 or V_{av34} 2335 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * $V_{12}/2$ ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	6363	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	4028	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = 34.0 (pc/mi/ln)

LOS = D (Exhibit 13-2)

Speed Determination

M_S = 0.502 (Exibit 13-11)

S_R= 51.0 mph (Exhibit 13-11)

S_0= 53.3 mph (Exhibit 13-11)

S = 51.8 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * $V_{12}/2$ ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-26 WB
Agency or Company	Atkins	Junction	2160-WB Off to Dorchester
Date Performed	3/20/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2038 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Number of Lanes, N	3	Downstream Adj Ramp	
☑ Yes	☑ On	Acceleration Lane Length, L_A		☐ Yes	☐ On
☐ No	☐ Off	Deceleration Lane Length L_D	425	☑ No	☐ Off
L_{up} =	2390 ft	Freeway Volume, V_F	4280	L_{down} =	ft
V_u =	167 veh/h	Ramp Volume, V_R	379	V_D =	veh/h
		Freeway Free-Flow Speed, S_{FF}	60.0		
		Ramp Free-Flow Speed, S_{FR}	45.0		

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	4280	0.90	Level	8	0	0.962	1.00	4946
Ramp	379	0.90	Level	20	0	0.909	1.00	463
UpStream	167	0.90	Level	25	0	0.889	1.00	209
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = 1397.34 (Equation 13-12 or 13-13)

P_{FD} = 0.615 using Equation (Exhibit 13-7)

V_{12} = 3220 pc/h

V_3 or V_{av34} 1726 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	4946	Exhibit 13-8	6900	No
$V_{FO} = V_F - V_R$	4483	Exhibit 13-8	6900	No
V_R	463	Exhibit 13-10	2100	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	3220	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = 28.1 (pc/mi/ln)

LOS = D (Exhibit 13-2)

Speed Determination

D_s = 0.340 (Exhibit 13-12)

S_R= 53.9 mph (Exhibit 13-12)

S_0= 63.0 mph (Exhibit 13-12)

S = 56.7 mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-26 WB
Agency or Company	Atkins	Junction	2160-WB Off to Dorchester
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2038 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Number of Lanes, N	3	Downstream Adj Ramp	
☑ Yes	☑ On	Acceleration Lane Length, L_A		☐ Yes	☐ On
☐ No	☐ Off	Deceleration Lane Length L_D	425	☑ No	☐ Off
L_{up} =	2390 ft	Freeway Volume, V_F	5528	L_{down} =	ft
V_u =	344 veh/h	Ramp Volume, V_R	456	V_D =	veh/h
		Freeway Free-Flow Speed, S_{FF}	60.0		
		Ramp Free-Flow Speed, S_{FR}	45.0		

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	5528	0.90	Level	7	0	0.966	1.00	6357
Ramp	456	0.90	Level	14	0	0.935	1.00	542
UpStream	344	0.90	Level	10	0	0.952	1.00	401
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = 2278.16 (Equation 13-12 or 13-13)

P_{FD} = 0.576 using Equation (Exhibit 13-7)

V_{12} = 3892 pc/h

V_3 or V_{av34} 2465 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	6357	Exhibit 13-8	6900	No
$V_{FO} = V_F - V_R$	5815	Exhibit 13-8	6900	No
V_R	542	Exhibit 13-10	2100	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	3892	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = 33.9 (pc/mi/ln)

LOS = D (Exhibit 13-2)

Speed Determination

D_s = 0.347 (Exhibit 13-12)

S_R= 53.8 mph (Exhibit 13-12)

S_0= 60.1 mph (Exhibit 13-12)

S = 56.1 mph (Exhibit 13-13)

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-26 WB*
Agency or Company	*Atkins*	From/To	*2165-Dorches Off to Dorches On*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2038 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*3901*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*8*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.962*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*3*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*60.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*60.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1503*	pc/h/ln
S	*60.0*	mph
D = v_p / S	*25.0*	pc/mi/ln
LOS	*C*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-26 WB*
Agency or Company	*Atkins*	From/To	*2165-Dorches Off to Dorches On*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*PM Peak*	Analysis Year	*2038 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*5072*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*7*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.966*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*3*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*60.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*60.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1944*	pc/h/ln
S	*57.9*	mph
D = v_p / S	*33.6*	pc/mi/ln
LOS	*D*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-26 WB
Agency or Company	Atkins	Junction	2170 - WB On from Dorchester
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2038 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Number of Lanes, N: 3	☐ Yes ☐ On
☑ No ☐ Off	Acceleration Lane Length, L_A: 600	☑ No ☐ Off
L_{up} = ft	Deceleration Lane Length L_D:	L_{down} = ft
V_u = veh/h	Freeway Volume, V_F: 3901	V_D = veh/h
	Ramp Volume, V_R: 258	
	Freeway Free-Flow Speed, S_{FF}: 60.0	
	Ramp Free-Flow Speed, S_{FR}: 45.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	3901	0.90	Level	8	0	0.962	1.00	4508
Ramp	258	0.90	Level	23	0	0.897	1.00	320
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 0.594 using Equation (Exhibit 13-6)

V_{12} = 2679 pc/h

V_3 or V_{av34} 1829 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	4828	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	2999	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = 25.0 (pc/mi/ln)

LOS = C (Exhibit 13-2)

Speed Determination

M_S = 0.345 (Exibit 13-11)

S_R= 53.8 mph (Exhibit 13-11)

S_0= 55.2 mph (Exhibit 13-11)

S = 54.3 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-26 WB
Agency or Company	Atkins	Junction	2170 - WB On from Dorchester
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2038 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Number of Lanes, N: 3	☐ Yes ☐ On
☑ No ☐ Off	Acceleration Lane Length, L_A: 600	☑ No ☐ Off
L_{up} = ft	Deceleration Lane Length L_D	L_{down} = ft
V_u = veh/h	Freeway Volume, V_F: 5072	V_D = veh/h
	Ramp Volume, V_R: 557	
	Freeway Free-Flow Speed, S_{FF}: 60.0	
	Ramp Free-Flow Speed, S_{FR}: 45.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	5072	0.90	Level	7	0	0.966	1.00	5833
Ramp	557	0.90	Level	9	0	0.957	1.00	647
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 0.594 using Equation (Exhibit 13-6)

V_{12} = 3467 pc/h

V_3 or V_{av34} 2366 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	6480	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	4114	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = 33.5 (pc/mi/ln)

LOS = D (Exhibit 13-2)

Speed Determination

M_S = 0.506 (Exibit 13-11)

S_R= 50.9 mph (Exhibit 13-11)

S_0= 53.1 mph (Exhibit 13-11)

S = 51.7 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-26 WB*
Agency or Company	*Atkins*	From/To	*2180 - Dorchester to Montague*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2038 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*4159*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*7*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.966*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*3*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*60.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*60.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1594*	pc/h/ln
S	*60.0*	mph
D = v_p / S	*26.6*	pc/mi/ln
LOS	*D*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-26 WB*
Agency or Company	*Atkins*	From/To	*2180 - Dorchester to Montague*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*PM Peak*	Analysis Year	*2038 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*5629*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*6*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.971*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*3*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*60.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*60.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*2147*	pc/h/ln
S	*54.6*	mph
D = v_p / S	*39.3*	pc/mi/ln
LOS	*E*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-26 WB
Agency or Company	Atkins	Junction	2190-WB Off to Montague
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2038 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Number of Lanes, N: 3	☐ Yes ☐ On
☑ No ☐ Off	Acceleration Lane Length, L_A:	☑ No ☐ Off
L_{up} = ft	Deceleration Lane Length L_D: 240	L_{down} = ft
V_u = veh/h	Freeway Volume, V_F: 4159	V_D = veh/h
	Ramp Volume, V_R: 1158	
	Freeway Free-Flow Speed, S_{FF}: 60.0	
	Ramp Free-Flow Speed, S_{FR}: 45.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	4159	0.90	Level	7	0	0.966	1.00	4783
Ramp	1158	0.90	Level	13	0	0.939	1.00	1370
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 0.577 using Equation (Exhibit 13-7)

V_{12} = 3341 pc/h

V_3 or V_{av34} 1442 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	4783	Exhibit 13-8	6900	No
$V_{FO} = V_F - V_R$	3413	Exhibit 13-8	6900	No
V_R	1370	Exhibit 13-10	2100	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	3341	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = 30.8 (pc/mi/ln)

LOS = D (Exhibit 13-2)

Speed Determination

D_s = 0.421 (Exhibit 13-12)

S_R= 52.4 mph (Exhibit 13-12)

S_0= 64.1 mph (Exhibit 13-12)

S = 55.5 mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-26 WB
Agency or Company	Atkins	Junction	2190-WB Off to Montague
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2038 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Number of Lanes, N	3	Downstream Adj Ramp	
☐ Yes	☐ On	Acceleration Lane Length, L_A		☐ Yes	☐ On
☑ No	☐ Off	Deceleration Lane Length L_D	240	☑ No	☐ Off
L_{up} =	ft	Freeway Volume, V_F	5629	L_{down} =	ft
		Ramp Volume, V_R	1173		
V_u =	veh/h	Freeway Free-Flow Speed, S_{FF}	60.0	V_D =	veh/h
		Ramp Free-Flow Speed, S_{FR}	45.0		

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	5629	0.90	Level	6	0	0.971	1.00	6442
Ramp	1173	0.90	Level	11	0	0.948	1.00	1375
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 0.536 using Equation (Exhibit 13-7)

V_{12} = 4089 pc/h

V_3 or V_{av34} 2353 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	6442	Exhibit 13-8	6900	No
$V_{FO} = V_F - V_R$	5067	Exhibit 13-8	6900	No
V_R	1375	Exhibit 13-10	2100	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	4089	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = 37.3 (pc/mi/ln)

LOS = E (Exhibit 13-2)

Speed Determination

D_s = 0.422 (Exhibit 13-12)

S_R= 52.4 mph (Exhibit 13-12)

S_0= 60.5 mph (Exhibit 13-12)

S = 55.1 mph (Exhibit 13-13)

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-26 WB*
Agency or Company	*Atkins*	From/To	*2195-Montagu Off to Montagu On*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2038 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*3001*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*8*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.962*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*3*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*60.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*60.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1156*	pc/h/ln
S	*60.0*	mph
D = v_p / S	*19.3*	pc/mi/ln
LOS	*C*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-26 WB*
Agency or Company	*Atkins*	From/To	*2195-Montagu Off to Montagu On*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*PM Peak*	Analysis Year	*2038 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*4456*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*6*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.971*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*3*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*60.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*60.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1700*	pc/h/ln
S	*59.8*	mph
D = v_p / S	*28.4*	pc/mi/ln
LOS	*D*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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Navy Base ICTF

FREEWAY WEAVING WORKSHEET

General Information

Analyst	AJR
Agency/Company	Atkins
Date Performed	7/25/2014
Analysis Time Period	AM Peak

Site Information

Freeway/Dir of Travel	I-26 WB
Weaving Segment Location	2200 - Montague to I-526 EB
Analysis Year	2038 No Action

Project Description *Navy Base ICTF*

Inputs

Weaving configuration	One-Sided	Segment type	Freeway
Weaving number of lanes, N	4	Freeway minimum speed, S_{MIN}	15
Weaving segment length, L_S	1920ft	Freeway maximum capacity, C_{IFL}	2300
Freeway free-flow speed, FFS	60 mph	Terrain type	Level

Conversions to pc/h Under Base Conditions

	V (veh/h)	PHF	Truck (%)	RV (%)	E_T	E_R	f_{HV}	f_p	v (pc/h)
V_{FF}	2532	0.90	8	0	1.5	1.2	0.962	1.00	2926
V_{RF}	404	0.90	25	0	1.5	1.2	0.889	1.00	505
V_{FR}	469	0.90	8	0	1.5	1.2	0.962	1.00	542
V_{RR}	75	0.90	25	0	1.5	1.2	0.889	1.00	94
V_{NW}	3020							V =	4067
V_W	1047								
VR	0.257								

Configuration Characteristics

Minimum maneuver lanes, N_{WL}	2 lc	Minimum weaving lane changes, LC_{MIN}	1047 lc/h
Interchange density, ID	0.8 int/mi	Weaving lane changes, LC_W	1449 lc/h
Minimum RF lane changes, LC_{RF}	1 lc/pc	Non-weaving lane changes, LC_{NW}	892 lc/h
Minimum FR lane changes, LC_{FR}	1 lc/pc	Total lane changes, LC_{ALL}	2341 lc/h
Minimum RR lane changes, LC_{RR}	lc/pc	Non-weaving vehicle index, I_{NW}	464

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment flow rate, v	4067 pc/h	Weaving intensity factor, W	0.264
Weaving segment capacity, c_w	7900 veh/h	Weaving segment speed, S	48.3 mph
Weaving segment v/c ratio	0.495	Average weaving speed, S_W	50.6 mph
Weaving segment density, D	21.0 pc/mi/ln	Average non-weaving speed, S_{NW}	47.6 mph
Level of Service, LOS	C	Maximum weaving length, L_{MAX}	5132 ft

Notes

a. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments".
b. For volumes that exceed the weaving segment capacity, the level of service is "F".

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Navy Base ICTF

FREEWAY WEAVING WORKSHEET

General Information

Analyst	AJR
Agency/Company	Atkins
Date Performed	7/25/2014
Analysis Time Period	PM Peak

Site Information

Freeway/Dir of Travel	I-26 WB
Weaving Segment Location	2200 - Montague to I-526 EB
Analysis Year	2038 No Action

Project Description *Navy Base ICTF*

Inputs

Weaving configuration	One-Sided	Segment type	Freeway
Weaving number of lanes, N	4	Freeway minimum speed, S_{MIN}	15
Weaving segment length, L_S	1920ft	Freeway maximum capacity, C_{IFL}	2300
Freeway free-flow speed, FFS	60 mph	Terrain type	Level

Conversions to pc/h Under Base Conditions

	V (veh/h)	PHF	Truck (%)	RV (%)	E_T	E_R	f_{HV}	f_p	v (pc/h)
V_{FF}	4078	0.90	6	0	1.5	1.2	0.971	1.00	4667
V_{RF}	1213	0.90	8	0	1.5	1.2	0.962	1.00	1402
V_{FR}	378	0.90	8	0	1.5	1.2	0.962	1.00	437
V_{RR}	112	0.90	8	0	1.5	1.2	0.962	1.00	129
V_{NW}	4796							V =	6635
V_W	1839								
VR	0.277								

Configuration Characteristics

Minimum maneuver lanes, N_{WL}	2 lc	Minimum weaving lane changes, LC_{MIN}	1839 lc/h
Interchange density, ID	0.8 int/mi	Weaving lane changes, LC_W	2241 lc/h
Minimum RF lane changes, LC_{RF}	1 lc/pc	Non-weaving lane changes, LC_{NW}	1258 lc/h
Minimum FR lane changes, LC_{FR}	1 lc/pc	Total lane changes, LC_{ALL}	3499 lc/h
Minimum RR lane changes, LC_{RR}	lc/pc	Non-weaving vehicle index, I_{NW}	737

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment flow rate, v	6635 pc/h	Weaving intensity factor, W	0.363
Weaving segment capacity, c_w	7915 veh/h	Weaving segment speed, S	41.0 mph
Weaving segment v/c ratio	0.814	Average weaving speed, S_W	48.0 mph
Weaving segment density, D	40.5 pc/mi/ln	Average non-weaving speed, S_{NW}	38.8 mph
Level of Service, LOS	E	Maximum weaving length, L_{MAX}	5340 ft

Notes

a. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments".
b. For volumes that exceed the weaving segment capacity, the level of service is "F".

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-26 WB
Agency or Company	Atkins	Junction	2210-WB Off to I-526 WB
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2038 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Number of Lanes, N: 3	☐ Yes ☐ On
☑ No ☐ Off	Acceleration Lane Length, L_A:	☑ No ☐ Off
L_{up} = ft	Deceleration Lane Length L_D: 830	L_{down} = ft
V_u = veh/h	Freeway Volume, V_F: 2936	V_D = veh/h
	Ramp Volume, V_R: 275	
	Freeway Free-Flow Speed, S_{FF}: 60.0	
	Ramp Free-Flow Speed, S_{FR}: 25.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	2936	0.90	Level	14	0	0.935	1.00	3491
Ramp	275	0.90	Level	7	0	0.966	1.00	316
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 0.658 using Equation (Exhibit 13-7)

V_{12} = 2406 pc/h

V_3 or V_{av34} 1085 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	3491	Exhibit 13-8	6900	No
$V_{FO} = V_F - V_R$	3175	Exhibit 13-8	6900	No
V_R	316	Exhibit 13-10	1900	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	2406	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = 17.5 (pc/mi/ln)

LOS = B (Exhibit 13-2)

Speed Determination

D_s = 0.586 (Exhibit 13-12)

S_R= 49.4 mph (Exhibit 13-12)

S_0= 65.5 mph (Exhibit 13-12)

S = 53.5 mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-26 WB
Agency or Company	Atkins	Junction	2210-WB Off to I-526 WB
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2038 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Number of Lanes, N: 3	☐ Yes ☐ On
☑ No ☐ Off	Acceleration Lane Length, L_A	☑ No ☐ Off
L_{up} = ft	Deceleration Lane Length L_D: 830	L_{down} = ft
V_u = veh/h	Freeway Volume, V_F: 5291	V_D = veh/h
	Ramp Volume, V_R: 338	
	Freeway Free-Flow Speed, S_{FF}: 60.0	
	Ramp Free-Flow Speed, S_{FR}: 25.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	5291	0.90	Level	11	0	0.948	1.00	6202
Ramp	338	0.90	Level	5	0	0.976	1.00	385
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 0.587 using Equation (Exhibit 13-7)

V_{12} = 3801 pc/h

V_3 or V_{av34} 2401 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	6202	Exhibit 13-8	6900	No
$V_{FO} = V_F - V_R$	5817	Exhibit 13-8	6900	No
V_R	385	Exhibit 13-10	1900	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	3801	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = 29.5 (pc/mi/ln)

LOS = D (Exhibit 13-2)

Speed Determination

D_s = 0.593 (Exhibit 13-12)

S_R= 49.3 mph (Exhibit 13-12)

S_0= 60.4 mph (Exhibit 13-12)

S = 53.1 mph (Exhibit 13-13)

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-26 WB*
Agency or Company	*Atkins*	From/To	*2215- I-526 WB Off to EB&WB On*
Date Performed	*4/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2038 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*2661*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*14*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.935*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*3*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*60.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*60.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1055*	pc/h/ln
S	*60.0*	mph
D = v_p / S	*17.6*	pc/mi/ln
LOS	*B*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-26 WB*
Agency or Company	*Atkins*	From/To	*2215- I-526 WB Off to EB&WB On*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*PM Peak*	Analysis Year	*2038 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*4953*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*11*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.948*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*3*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*60.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*60.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1935*	pc/h/ln
S	*58.0*	mph
D = v_p / S	*33.4*	pc/mi/ln
LOS	*D*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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RAMP ADD OR DROP LANE ANALYSIS (MAINLINE <55 MPH)

ATKINS

General Information

Date Performed:	7/25/2014	Freeway/Direction	I-26 WB
Analysis Year	2038 No Action	Junction	On from 526 WB & EB
Analysis Time Period:	AM Peak	Segment ID	2218
Project Description:	Navy Base ICTF		

Inputs

	Mainline Upstream Ramp	Mainline Downstream Ramp	Ramp
Number of Lanes, N	1	2	1
Free-Flow Speed, FFS (mph)	55	55	55
Volume, V (veh/h)	2,168	3,525	1,357
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	10%	27%	54%
%RVs, P_R	0%	0%	0%

Performance Measures

	Upstream of Off-Ramp	Downstream of Off-Ramp	Off-Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.95	0.88	0.79
Demand Flow Rate, v_p (pc/h/ln)	2,529	2,223	1,915
Capacity Flow Rate, c (pc/h/ln)	2,200	2,200	2,200
v/c ratio	1.15	1.01	0.87
Density, D_{MD} (pc/mi/ln)	44.3	38.9	33.5
LOS	F	F	D

Formulas and Reference Material

$$f_{HV} = \frac{1}{1+P_T(E_T-1)+P_R(E_R-1)}$$ HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P}$$ HCM 2010, Equation 11-2

$$D_{MD} = \frac{0.0175*v_f}{N}$$ HCM 2010, Equation 13-26

Ramp Roadways Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

Diverge LOS Thresholds

LOS	Density (pc/mi/ln)
A	≤10
B	>10-20
C	>20-28
D	>28-35
E	>35
F	v/c > 1

Source: HCM 2010, Exhibit 13-2

RAMP ADD OR DROP LANE ANALYSIS (MAINLINE <55 MPH)

ATKINS

General Information

Date Performed:	7/25/2014	Freeway/Direction	I-26 WB
Analysis Year	2038 No Action	Junction	On from 526 WB & EB
Analysis Time Period:	PM Peak	Segment ID	2218
Project Description:	Navy Base ICTF		

Inputs

	Mainline Upstream Ramp	Mainline Downstream Ramp	Ramp
Number of Lanes, N	1	2	1
Free-Flow Speed, FFS (mph)	55	55	55
Volume, V (veh/h)	2,507	4,141	1,634
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	7%	20%	39%
%RVs, P_R	0%	0%	0%

Performance Measures

	Upstream of Off-Ramp	Downstream of Off-Ramp	Off-Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.97	0.91	0.84
Demand Flow Rate, v_p (pc/h/ln)	2,883	2,531	2,170
Capacity Flow Rate, c (pc/h/ln)	2,200	2,200	2,200
v/c ratio	1.31	1.15	0.99
Density, D_{MD} (pc/mi/ln)	50.5	44.3	38.0
LOS	F	F	E

Formulas and Reference Material

$$f_{HV} = \frac{1}{1+P_T(E_T-1)+P_R(E_R-1)}$$ HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P}$$ HCM 2010, Equation 11-2

$$D_{MD} = \frac{0.0175*v_f}{N}$$ HCM 2010, Equation 13-26

Ramp Roadways Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

Diverge LOS Thresholds

LOS	Density (pc/mi/ln)
A	≤10
B	>10-20
C	>20-28
D	>28-35
E	>35
F	v/c > 1

Source: HCM 2010, Exhibit 13-2

Navy Base ICTF

FREEWAY WEAVING WORKSHEET

General Information

Analyst	AJR
Agency/Company	Atkins
Date Performed	7/25/2014
Analysis Time Period	AM Peak

Site Information

Freeway/Dir of Travel	I-26 WB
Weaving Segment Location	2220 - 526 to Rem/Aviation C-D
Analysis Year	2038 No Action

Project Description *Navy Base ICTF*

Inputs

Weaving configuration	One-Sided	Segment type	Freeway
Weaving number of lanes, N	5	Freeway minimum speed, S_{MIN}	15
Weaving segment length, L_S	2285ft	Freeway maximum capacity, C_{IFL}	2300
Freeway free-flow speed, FFS	60 mph	Terrain type	Level

Conversions to pc/h Under Base Conditions

	V (veh/h)	PHF	Truck (%)	RV (%)	E_T	E_R	f_{HV}	f_p	v (pc/h)
V_{FF}	2023	0.90	14	0	1.5	1.2	0.935	1.00	2405
V_{RF}	2681	0.90	27	0	1.5	1.2	0.881	1.00	3381
V_{FR}	638	0.90	14	0	1.5	1.2	0.935	1.00	759
V_{RR}	844	0.90	27	0	1.5	1.2	0.881	1.00	1064
V_{NW}	3469							V =	7609
V_W	4140								
VR	0.544								

Configuration Characteristics

Minimum maneuver lanes, N_{WL}	3 lc	Minimum weaving lane changes, LC_{MIN}	lc/h
Interchange density, ID	0.7 int/mi	Weaving lane changes, LC_W	lc/h
Minimum RF lane changes, LC_{RF}	0 lc/pc	Non-weaving lane changes, LC_{NW}	lc/h
Minimum FR lane changes, LC_{FR}	1 lc/pc	Total lane changes, LC_{ALL}	lc/h
Minimum RR lane changes, LC_{RR}	lc/pc	Non-weaving vehicle index, I_{NW}	360

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment flow rate, v	7609 pc/h	Weaving intensity factor, W	
Weaving segment capacity, c_w	6012 veh/h	Weaving segment speed, S	mph
Weaving segment v/c ratio	1.183	Average weaving speed, S_W	mph
Weaving segment density, D	pc/mi/ln	Average non-weaving speed, S_{NW}	mph
Level of Service, LOS	F	Maximum weaving length, L_{MAX}	6780 ft

Notes

a. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments".
b. For volumes that exceed the weaving segment capacity, the level of service is "F".

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Navy Base ICTF

FREEWAY WEAVING WORKSHEET

General Information

Analyst	AJR
Agency/Company	Atkins
Date Performed	7/25/2014
Analysis Time Period	PM Peak

Site Information

Freeway/Dir of Travel	I-26 WB
Weaving Segment Location	2220 - 526 to Rem/Aviation C-D
Analysis Year	2038 No Action

Project Description *Navy Base ICTF*

Inputs

Weaving configuration	One-Sided	Segment type	Freeway
Weaving number of lanes, N	5	Freeway minimum speed, S_{MIN}	15
Weaving segment length, L_S	2285ft	Freeway maximum capacity, C_{IFL}	2300
Freeway free-flow speed, FFS	60 mph	Terrain type	Level

Conversions to pc/h Under Base Conditions

	V (veh/h)	PHF	Truck (%)	RV (%)	E_T	E_R	f_{HV}	f_p	v (pc/h)
V_{FF}	4335	0.90	11	0	1.5	1.2	0.948	1.00	5082
V_{RF}	3625	0.90	20	0	1.5	1.2	0.909	1.00	4431
V_{FR}	618	0.90	11	0	1.5	1.2	0.948	1.00	724
V_{RR}	516	0.90	20	0	1.5	1.2	0.909	1.00	631
V_{NW}	5713							V =	10868
V_W	5155								
VR	0.474								

Configuration Characteristics

Minimum maneuver lanes, N_{WL}	3 lc	Minimum weaving lane changes, LC_{MIN}	lc/h
Interchange density, ID	0.7 int/mi	Weaving lane changes, LC_W	lc/h
Minimum RF lane changes, LC_{RF}	0 lc/pc	Non-weaving lane changes, LC_{NW}	lc/h
Minimum FR lane changes, LC_{FR}	1 lc/pc	Total lane changes, LC_{ALL}	lc/h
Minimum RR lane changes, LC_{RR}	lc/pc	Non-weaving vehicle index, I_{NW}	

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment flow rate, v	10868 pc/h	Weaving intensity factor, W	
Weaving segment capacity, c_w	6994 veh/h	Weaving segment speed, S	mph
Weaving segment v/c ratio	1.473	Average weaving speed, S_W	mph
Weaving segment density, D	pc/mi/ln	Average non-weaving speed, S_{NW}	mph
Level of Service, LOS	F	Maximum weaving length, L_{MAX}	5962 ft

Notes

a. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments".
b. For volumes that exceed the weaving segment capacity, the level of service is "F".

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-26 WB*
Agency or Company	*Atkins*	From/To	*2225- Rem/Avia CD Off to CD On*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2038 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*4704*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*16*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.926*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*4*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*60.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*60.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1411*	pc/h/ln
S	*60.0*	mph
D = v_p / S	*23.5*	pc/mi/ln
LOS	*C*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-26 WB*
Agency or Company	*Atkins*	From/To	*2225- Rem/Avia CD Off to CD On*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*PM Peak*	Analysis Year	*2038 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*7960*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*13*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.939*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*4*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*60.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*60.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*2355*	pc/h/ln
S	*49.6*	mph
D = v_p / S	*47.4*	pc/mi/ln
LOS	*F*	

Design (N)

Design (N)

Design LOS	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h/ln
S	mph
D = v_p / S	pc/mi/ln
Required Number of Lanes, N	

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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RAMP ADD OR DROP LANE ANALYSIS (MAINLINE <55 MPH)

ATKINS

General Information

Date Performed:	7/25/2014	Freeway/Direction	I-26 WB C-D
Analysis Year	2038 No Action	Junction	WB Off to Remount
Analysis Time Period:	AM Peak	Segment ID	2230
Project Description:	Navy Base ICTF		

Inputs

	Mainline Upstream Ramp	Mainline Downstream Ramp	Ramp
Number of Lanes, N	2	1	1
Free-Flow Speed, FFS (mph)	55	55	45
Volume, V (veh/h)	1,482	849	633
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	4%	4%	4%
%RVs, P_R	0%	0%	0%

Performance Measures

	Upstream of Off-Ramp	Downstream of Off-Ramp	Off-Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.98	0.98	0.98
Demand Flow Rate, v_p (pc/h/ln)	840	962	717
Capacity Flow Rate, c (pc/h/ln)	2,200	2,200	2,100
v/c ratio	0.38	0.44	0.34
Density, D_{MD} (pc/mi/ln)	14.7	16.8	12.5
LOS	B	B	B

Formulas and Reference Material

$$f_{HV} = \frac{1}{1+P_T(E_T-1)+P_R(E_R-1)}$$ HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P}$$ HCM 2010, Equation 11-2

$$D_{MD} = \frac{0.0175*v_f}{N}$$ HCM 2010, Equation 13-26

Ramp Roadways Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

Diverge LOS Thresholds

LOS	Density (pc/mi/ln)
A	≤10
B	>10-20
C	>20-28
D	>28-35
E	>35
F	v/c > 1

Source: HCM 2010, Exhibit 13-2

RAMP ADD OR DROP LANE ANALYSIS (MAINLINE <55 MPH)

ATKINS

General Information

Date Performed:	7/25/2014	Freeway/Direction	I-26 WB C-D
Analysis Year	2038 No Action	Junction	WB Off to Remount
Analysis Time Period:	PM Peak	Segment ID	2230
Project Description:	Navy Base ICTF		

Inputs

	Mainline Upstream Ramp	Mainline Downstream Ramp	Ramp
Number of Lanes, N	2	1	1
Free-Flow Speed, FFS (mph)	55	55	45
Volume, V (veh/h)	1,134	554	580
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	5%	6%	4%
%RVs, P_R	0%	0%	0%

Performance Measures

	Upstream of Off-Ramp	Downstream of Off-Ramp	Off-Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.98	0.97	0.98
Demand Flow Rate, v_p (pc/h/ln)	646	634	657
Capacity Flow Rate, c (pc/h/ln)	2,200	2,200	2,100
v/c ratio	0.29	0.29	0.31
Density, D_{MD} (pc/mi/ln)	11.3	11.1	11.5
LOS	B	B	B

Formulas and Reference Material

$$f_{HV} = \frac{1}{1+P_T(E_T-1)+P_R(E_R-1)}$$ HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P}$$ HCM 2010, Equation 11-2

$$D_{MD} = \frac{0.0175*v_f}{N}$$ HCM 2010, Equation 13-26

Ramp Roadways Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

Diverge LOS Thresholds

LOS	Density (pc/mi/ln)
A	≤10
B	>10-20
C	>20-28
D	>28-35
E	>35
F	v/c > 1

Source: HCM 2010, Exhibit 13-2

BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-26 WB C-D*
Agency or Company	*Atkins*	From/To	*2235-Remount Off to Remount On*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2038 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*1648*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*4*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.980*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*55.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*55.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*934*	pc/h/ln
S	*55.0*	mph
D = v_p / S	*17.0*	pc/mi/ln
LOS	*B*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-26 WB C-D*
Agency or Company	*Atkins*	From/To	*2235-Remount Off to Remount On*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*PM Peak*	Analysis Year	*2038 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*1105*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*6*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.971*

Speed Inputs			Calc Speed Adj and FFS		
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f_{LW}		mph
Number of Lanes, N	*2*		f_{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	*55.0*	mph	FFS	*55.0*	mph
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures			Design (N)	
Operational (LOS)			Design (N)	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*632*	pc/h/ln	Design LOS	
			v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h/ln
S	*55.0*	mph	S	mph
D = v_p / S	*11.5*	pc/mi/ln	D = v_p / S	pc/mi/ln
LOS	*B*		Required Number of Lanes, N	

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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Navy Base ICTF

FREEWAY WEAVING WORKSHEET

General Information

Analyst	AJR
Agency/Company	Atkins
Date Performed	7/25/2014
Analysis Time Period	AM Peak

Site Information

Freeway/Dir of Travel	I-26 WB C-D
Weaving Segment Location	2240 - Remount to Aviation
Analysis Year	2038 No Action

Project Description *Navy Base ICTF*

Inputs

Weaving configuration	One-Sided
Weaving number of lanes, N	2
Weaving segment length, L_S	750ft
Freeway free-flow speed, FFS	55 mph
Segment type	C-D Roadway/ Multilane Highways
Freeway minimum speed, S_{MIN}	15
Freeway maximum capacity, C_{IFL}	2250
Terrain type	Level

Conversions to pc/h Under Base Conditions

	V (veh/h)	PHF	Truck (%)	RV (%)	E_T	E_R	f_{HV}	f_p	v (pc/h)
V_{FF}	0	0.90	0	0	1.5	1.2	1.000	1.00	0
V_{RF}	291	0.90	18	0	1.5	1.2	0.917	1.00	352
V_{FR}	849	0.90	4	0	1.5	1.2	0.980	1.00	962
V_{RR}	0	0.90	0	0	1.5	1.2	1.000	1.00	0
V_{NW}	0							V =	1314
V_W	1314								
VR	1.000								

Configuration Characteristics

Minimum maneuver lanes, N_{WL}	2 lc	Minimum weaving lane changes, LC_{MIN}	1314 lc/h
Interchange density, ID	0.8 int/mi	Weaving lane changes, LC_W	1367 lc/h
Minimum RF lane changes, LC_{RF}	1 lc/pc	Non-weaving lane changes, LC_{NW}	21 lc/h
Minimum FR lane changes, LC_{FR}	1 lc/pc	Total lane changes, LC_{ALL}	1388 lc/h
Minimum RR lane changes, LC_{RR}	lc/pc	Non-weaving vehicle index, I_{NW}	0

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment flow rate, v	1314 pc/h	Weaving intensity factor, W	0.367
Weaving segment capacity, c_w	2400 veh/h	Weaving segment speed, S	44.3 mph
Weaving segment v/c ratio	0.548	Average weaving speed, S_W	44.3 mph
Weaving segment density, D	14.8 pc/mi/ln	Average non-weaving speed, S_{NW}	42.4 mph
Level of Service, LOS	B	Maximum weaving length, L_{MAX}	14232 ft

Notes

a. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments".
b. For volumes that exceed the weaving segment capacity, the level of service is "F".

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Navy Base ICTF

FREEWAY WEAVING WORKSHEET

General Information

Analyst	AJR
Agency/Company	Atkins
Date Performed	7/25/2014
Analysis Time Period	PM Peak

Site Information

Freeway/Dir of Travel	I-26 WB C-D
Weaving Segment Location	2240 - Remount to Aviation
Analysis Year	2038 No Action

Project Description *Navy Base ICTF*

Inputs

Weaving configuration	One-Sided
Weaving number of lanes, N	2
Weaving segment length, L_S	750ft
Freeway free-flow speed, FFS	55 mph
Segment type	C-D Roadway/ Multilane Highways
Freeway minimum speed, S_{MIN}	15
Freeway maximum capacity, C_{IFL}	2250
Terrain type	Level

Conversions to pc/h Under Base Conditions

	V (veh/h)	PHF	Truck (%)	RV (%)	E_T	E_R	f_{HV}	f_p	v (pc/h)
V_{FF}	0	0.90	0	0	1.5	1.2	1.000	1.00	0
V_{RF}	1060	0.90	4	0	1.5	1.2	0.980	1.00	1201
V_{FR}	554	0.90	6	0	1.5	1.2	0.971	1.00	634
V_{RR}	0	0.90	0	0	1.5	1.2	1.000	1.00	0
V_{NW}	0							V =	1835
V_W	1835								
VR	1.000								

Configuration Characteristics

Minimum maneuver lanes, N_{WL}	2 lc	Minimum weaving lane changes, LC_{MIN}	1835 lc/h
Interchange density, ID	0.8 int/mi	Weaving lane changes, LC_W	1888 lc/h
Minimum RF lane changes, LC_{RF}	1 lc/pc	Non-weaving lane changes, LC_{NW}	21 lc/h
Minimum FR lane changes, LC_{FR}	1 lc/pc	Total lane changes, LC_{ALL}	1909 lc/h
Minimum RR lane changes, LC_{RR}	lc/pc	Non-weaving vehicle index, I_{NW}	0

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment flow rate, v	1835 pc/h	Weaving intensity factor, W	0.472
Weaving segment capacity, c_w	2400 veh/h	Weaving segment speed, S	42.2 mph
Weaving segment v/c ratio	0.765	Average weaving speed, S_W	42.2 mph
Weaving segment density, D	21.8 pc/mi/ln	Average non-weaving speed, S_{NW}	37.4 mph
Level of Service, LOS	B	Maximum weaving length, L_{MAX}	14232 ft

Notes

a. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments".
b. For volumes that exceed the weaving segment capacity, the level of service is "F".

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-26 WB C-D*
Agency or Company	*Atkins*	From/To	*2245 - Avia Off to Avia EB On*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2038 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*582*	veh/h	Peak-Hour Factor, PHF	*0.90*	
AADT		veh/day	%Trucks and Buses, P_T	*18*	
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*	
Peak-Hr Direction Prop, D			General Terrain:	*Level*	
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*	

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.917*

Speed Inputs			Calc Speed Adj and FFS		
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f_{LW}		mph
Number of Lanes, N	*2*		f_{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	*55.0*	mph	FFS	*55.0*	mph
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures			Design (N)	
Operational (LOS)			Design (N)	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*352*	pc/h/ln	Design LOS	
			v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h/ln
S	*55.0*	mph	S	mph
D = v_p / S	*6.4*	pc/mi/ln	D = v_p / S	pc/mi/ln
LOS	*A*		Required Number of Lanes, N	

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-26 WB C-D*
Agency or Company	*Atkins*	From/To	*2245 - Avia Off to Avia EB On*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*PM Peak*	Analysis Year	*2038 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*2120*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*4*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.980*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*55.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*55.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1201*	pc/h/ln
S	*55.0*	mph
D = v_p / S	*21.8*	pc/mi/ln
LOS	*C*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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RAMP ADD OR DROP LANE ANALYSIS (MAINLINE <55 MPH)

ATKINS

General Information

Date Performed:	7/25/2014	Freeway/Direction	I-26 WB C-D
Analysis Year	2038 No Action	Junction	WB On from Aviation EB
Analysis Time Period:	AM Peak	Segment ID	2250
Project Description:	Navy Base ICTF		

Inputs

	Mainline Upstream Ramp	Mainline Downstream Ramp	Ramp
Number of Lanes, N	1	1	1
Free-Flow Speed, FFS (mph)	55	55	25
Volume, V (veh/h)	291	311	20
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	18%	18%	25%
%RVs, P_R	0%	0%	0%

Performance Measures

	Upstream of Off-Ramp	Downstream of Off-Ramp	Off-Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.92	0.92	0.89
Demand Flow Rate, v_p (pc/h/ln)	352	377	25
Capacity Flow Rate, c (pc/h/ln)	2,200	2,200	1,900
v/c ratio	0.16	0.17	0.01
Density, D_{MD} (pc/mi/ln)	6.2	6.6	0.4
LOS	A	A	A

Formulas and Reference Material

$$f_{HV} = \frac{1}{1+P_T(E_T-1)+P_R(E_R-1)}$$ HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P}$$ HCM 2010, Equation 11-2

$$D_{MD} = \frac{0.0175*v_f}{N}$$ HCM 2010, Equation 13-26

Ramp Roadways Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

Diverge LOS Thresholds

LOS	Density (pc/mi/ln)
A	≤10
B	>10-20
C	>20-28
D	>28-35
E	>35
F	v/c > 1

Source: HCM 2010, Exhibit 13-2

RAMP ADD OR DROP LANE ANALYSIS (MAINLINE <55 MPH)

ATKINS

General Information

Date Performed:	7/25/2014	Freeway/Direction	I-26 WB C-D
Analysis Year	2038 No Action	Junction	WB On from Aviation EB
Analysis Time Period:	PM Peak	Segment ID	2250
Project Description:	Navy Base ICTF		

Inputs

	Mainline Upstream Ramp	Mainline Downstream Ramp	Ramp
Number of Lanes, N	1	1	1
Free-Flow Speed, FFS (mph)	55	55	25
Volume, V (veh/h)	1,060	1,444	384
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	4%	3%	2%
%RVs, P_R	0%	0%	0%

Performance Measures

	Upstream of Off-Ramp	Downstream of Off-Ramp	Off-Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.98	0.99	0.99
Demand Flow Rate, v_p (pc/h/ln)	1,201	1,629	431
Capacity Flow Rate, c (pc/h/ln)	2,200	2,200	1,900
v/c ratio	0.55	0.74	0.23
Density, D_{MD} (pc/mi/ln)	21.0	28.5	7.5
LOS	C	D	A

Formulas and Reference Material

$$f_{HV} = \frac{1}{1+P_T(E_T-1)+P_R(E_R-1)}$$ HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P}$$ HCM 2010, Equation 11-2

$$D_{MD} = \frac{0.0175*v_f}{N}$$ HCM 2010, Equation 13-26

Ramp Roadways Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

Diverge LOS Thresholds

LOS	Density (pc/mi/ln)
A	≤10
B	>10-20
C	>20-28
D	>28-35
E	>35
F	v/c > 1

Source: HCM 2010, Exhibit 13-2

RAMP ADD OR DROP LANE ANALYSIS (MAINLINE <55 MPH)

ATKINS

General Information

Date Performed:	7/25/2014	Freeway/Direction	I-26 WB C-D
Analysis Year	2038 No Action	Junction	WB On from Aviation WB
Analysis Time Period:	AM Peak	Segment ID	2260
Project Description:	Navy Base ICTF		

Inputs

	Mainline Upstream Ramp	Mainline Downstream Ramp	Ramp
Number of Lanes, N	1	1	1
Free-Flow Speed, FFS (mph)	55	55	45
Volume, V (veh/h)	311	398	87
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	18%	17%	14%
%RVs, P_R	0%	0%	0%

Performance Measures

	Upstream of Off-Ramp	Downstream of Off-Ramp	Off-Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.92	0.92	0.93
Demand Flow Rate, v_p (pc/h/ln)	377	480	103
Capacity Flow Rate, c (pc/h/ln)	2,200	2,200	2,100
v/c ratio	0.17	0.22	0.05
Density, D_{MD} (pc/mi/ln)	6.6	8.4	1.8
LOS	A	A	A

Formulas and Reference Material

$$f_{HV} = \frac{1}{1+P_T(E_T-1)+P_R(E_R-1)}$$ HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P}$$ HCM 2010, Equation 11-2

$$D_{MD} = \frac{0.0175*v_f}{N}$$ HCM 2010, Equation 13-26

Ramp Roadways Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

Diverge LOS Thresholds

LOS	Density (pc/mi/ln)
A	≤10
B	>10-20
C	>20-28
D	>28-35
E	>35
F	v/c > 1

Source: HCM 2010, Exhibit 13-2

RAMP ADD OR DROP LANE ANALYSIS (MAINLINE <55 MPH)

ATKINS

General Information

Date Performed:	7/25/2014	Freeway/Direction	I-26 WB C-D
Analysis Year	2038 No Action	Junction	WB On from Aviation WB
Analysis Time Period:	PM Peak	Segment ID	2260
Project Description:	Navy Base ICTF		

Inputs

	Mainline Upstream Ramp	Mainline Downstream Ramp	Ramp
Number of Lanes, N	1	1	1
Free-Flow Speed, FFS (mph)	55	55	45
Volume, V (veh/h)	1,444	1,886	442
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	3%	3%	2%
%RVs, P_R	0%	0%	0%

Performance Measures

	Upstream of Off-Ramp	Downstream of Off-Ramp	Off-Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.99	0.99	0.99
Demand Flow Rate, v_p (pc/h/ln)	1,629	2,127	496
Capacity Flow Rate, c (pc/h/ln)	2,200	2,200	2,100
v/c ratio	0.74	0.97	0.24
Density, D_{MD} (pc/mi/ln)	28.5	37.2	8.7
LOS	D	E	A

Formulas and Reference Material

$$f_{HV} = \frac{1}{1+P_T(E_T-1)+P_R(E_R-1)}$$ HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P}$$ HCM 2010, Equation 11-2

$$D_{MD} = \frac{0.0175*v_f}{N}$$ HCM 2010, Equation 13-26

Ramp Roadways Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

Diverge LOS Thresholds

LOS	Density (pc/mi/ln)
A	≤10
B	>10-20
C	>20-28
D	>28-35
E	>35
F	v/c > 1

Source: HCM 2010, Exhibit 13-2

FREEWAY RAMP ADD OR DROP LANE ANALYSIS

ATKINS

General Information

Date Performed:	7/25/2014	Freeway/Direction	I-26 WB
Analysis Year	2038 No Action	Junction	From Rem/Aviation C-D
Analysis Time Period:	AM Peak	Segment ID	2270
Project Description:	Navy Base ICTF		

Inputs

	Freeway Upstream of Ramp	Freeway Downstream of Ramp	Ramp
Number of Lanes, N	4	5	1
Free-Flow Speed, FFS (mph)	60	60	55
Volume, V (veh/h)	4,704	5,102	398
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	16%	15%	17%
%RVs, P_R	0%	0%	0%

Performance Measures

	Freeway Upstream Ramp	Freeway Downstream Ramp	Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.93	0.93	0.92
Demand Flow Rate, v_p (pc/h/ln)	1,411	1,219	480
Capacity Flow Rate, c (pc/h/ln)	2,300	2,300	2,200
v/c ratio	0.61	0.53	0.22
Density, D_{MD} (pc/mi/ln)	24.7	21.3	8.4
LOS	C	C	A

Formulas and Reference Material

$$f_{HV} = \frac{1}{1 + P_T(E_T-1)+P_R(E_R-1)}$$ HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P}$$ HCM 2010, Equation 11-2

$$D_{MD} = \frac{0.0175*v_f}{N}$$ HCM 2010, Equation 13-26

Basic Freeway Segments Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
75	2,400
70	2,400
65	2,350
60	2,300
55	2,250

Source: HCM 2010, Exhibit 11-17

Ramp Roadways Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

Diverge LOS Thresholds

LOS	Density (pc/mi/ln)
A	≤10
B	>10-20
C	>20-28
D	>28-35
E	>35
F	v/c > 1

Source: HCM 2010, Exhibit 13-2

FREEWAY RAMP ADD OR DROP LANE ANALYSIS

ATKINS

General Information

Date Performed:	7/25/2014	Freeway/Direction	I-26 WB
Analysis Year	2038 No Action	Junction	From Rem/Aviation C-D
Analysis Time Period:	PM Peak	Segment ID	2270
Project Description:	Navy Base ICTF		

Inputs

	Freeway Upstream of Ramp	Freeway Downstream of Ramp	Ramp
Number of Lanes, N	4	5	1
Free-Flow Speed, FFS (mph)	60	60	55
Volume, V (veh/h)	7,960	9,846	1,886
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	13%	12%	3%
%RVs, P_R	0%	0%	0%

Performance Measures

	Freeway Upstream Ramp	Freeway Downstream Ramp	Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.94	0.94	0.99
Demand Flow Rate, v_p (pc/h/ln)	2,355	2,319	2,127
Capacity Flow Rate, c (pc/h/ln)	2,300	2,300	2,200
v/c ratio	1.02	1.01	0.97
Density, D_{MD} (pc/mi/ln)	41.2	40.6	37.2
LOS	F	F	E

Formulas and Reference Material

$$f_{HV} = \frac{1}{1 + P_T(E_T-1)+P_R(E_R-1)}$$

HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P}$$

HCM 2010, Equation 11-2

$$D_{MD} = \frac{0.0175*v_f}{N}$$

HCM 2010, Equation 13-26

Basic Freeway Segments Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
75	2,400
70	2,400
65	2,350
60	2,300
55	2,250

Source: HCM 2010, Exhibit 11-17

Ramp Roadways Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

Diverge LOS Thresholds

LOS	Density (pc/mi/ln)
A	≤10
B	>10-20
C	>20-28
D	>28-35
E	>35
F	v/c > 1

Source: HCM 2010, Exhibit 13-2

Appendix E
Traffic Analysis Worksheets

2038 Design Year

No Action Alternative

Interstate 526

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-526 EB
Agency or Company	Atkins	Junction	3010-EB Off to PaulCantrell EB
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2038 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Number of Lanes, N	2	Downstream Adj Ramp	
☐ Yes	☐ On	Acceleration Lane Length, L_A		☐ Yes	☐ On
☑ No	☐ Off	Deceleration Lane Length L_D	340	☑ No	☐ Off
L_{up} =	ft	Freeway Volume, V_F	2847	L_{down} =	ft
V_u =	veh/h	Ramp Volume, V_R	28	V_D =	veh/h
		Freeway Free-Flow Speed, S_{FF}	60.0		
		Ramp Free-Flow Speed, S_{FR}	45.0		

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	2847	0.90	Level	4	0	0.980	1.00	3227
Ramp	28	0.90	Level	36	0	0.847	1.00	37
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 1.000 using Equation (Exhibit 13-7)

V_{12} = 3227 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	3227	Exhibit 13-8	4600	No
$V_{FO} = V_F - V_R$	3190	Exhibit 13-8	4600	No
V_R	37	Exhibit 13-10	2100	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	3227	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = 28.9 (pc/mi/ln)

LOS = D (Exhibit 13-2)

Speed Determination

D_s = 0.301 (Exhibit 13-12)

S_R= 54.6 mph (Exhibit 13-12)

S_0= N/A mph (Exhibit 13-12)

S = 54.6 mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-526 EB
Agency or Company	Atkins	Junction	3010-EB Off to PaulCantrell EB
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2038 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Number of Lanes, N	2	Downstream Adj Ramp	
☐ Yes	☐ On	Acceleration Lane Length, L_A		☐ Yes	☐ On
☑ No	☐ Off	Deceleration Lane Length L_D	340	☑ No	☐ Off
L_{up} =	ft	Freeway Volume, V_F	2586	L_{down} =	ft
V_u =	veh/h	Ramp Volume, V_R	55	V_D =	veh/h
		Freeway Free-Flow Speed, S_{FF}	60.0		
		Ramp Free-Flow Speed, S_{FR}	45.0		

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	2586	0.90	Level	3	0	0.985	1.00	2916
Ramp	55	0.90	Level	15	0	0.930	1.00	66
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 1.000 using Equation (Exhibit 13-7)

V_{12} = 2916 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	2916	Exhibit 13-8	4600	No
$V_{FO} = V_F - V_R$	2850	Exhibit 13-8	4600	No
V_R	66	Exhibit 13-10	2100	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	2916	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = 26.3 (pc/mi/ln)

LOS = C (Exhibit 13-2)

Speed Determination

D_s = 0.304 (Exhibit 13-12)

S_R= 54.5 mph (Exhibit 13-12)

S_0= N/A mph (Exhibit 13-12)

S = 54.5 mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-526 EB
Agency or Company	Atkins	Junction	3020-EB Off to PaulCantrell WB
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2038 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Number of Lanes, N	2	Downstream Adj Ramp	
☐ Yes	☐ On	Acceleration Lane Length, L_A		☐ Yes	☐ On
☑ No	☐ Off	Deceleration Lane Length L_D	600	☑ No	☐ Off
L_{up} =	ft	Freeway Volume, V_F	2819	L_{down} =	ft
V_u =	veh/h	Ramp Volume, V_R	186	V_D =	veh/h
		Freeway Free-Flow Speed, S_{FF}	60.0		
		Ramp Free-Flow Speed, S_{FR}	25.0		

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	2819	0.90	Level	9	0	0.957	1.00	3273
Ramp	186	0.90	Level	7	0	0.966	1.00	214
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 1.000 using Equation (Exhibit 13-7)

V_{12} = 3273 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	3273	Exhibit 13-8	4600	No
$V_{FO} = V_F - V_R$	3059	Exhibit 13-8	4600	No
V_R	214	Exhibit 13-10	1900	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	3273	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = 27.0 (pc/mi/ln)

LOS = C (Exhibit 13-2)

Speed Determination

D_s = 0.577 (Exhibit 13-12)

S_R= 49.6 mph (Exhibit 13-12)

S_0= N/A mph (Exhibit 13-12)

S = 49.6 mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-526 EB
Agency or Company	Atkins	Junction	3020-EB Off to PaulCantrell WB
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2038 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Number of Lanes, N	2	Downstream Adj Ramp	
☐ Yes	☐ On	Acceleration Lane Length, L_A		☐ Yes	☐ On
☑ No	☐ Off	Deceleration Lane Length L_D	600	☑ No	☐ Off
L_{up} =	ft	Freeway Volume, V_F	2531	L_{down} =	ft
V_u =	veh/h	Ramp Volume, V_R	614	V_D =	veh/h
		Freeway Free-Flow Speed, S_{FF}	60.0		
		Ramp Free-Flow Speed, S_{FR}	25.0		

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	2531	0.90	Level	8	0	0.962	1.00	2925
Ramp	614	0.90	Level	2	0	0.990	1.00	689
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 1.000 using Equation (Exhibit 13-7)

V_{12} = 2925 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	2925	Exhibit 13-8	4600	No
$V_{FO} = V_F - V_R$	2236	Exhibit 13-8	4600	No
V_R	689	Exhibit 13-10	1900	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	2925	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = 24.0 (pc/mi/ln)

LOS = C (Exhibit 13-2)

Speed Determination

D_s = 0.620 (Exhibit 13-12)

S_R= 48.8 mph (Exhibit 13-12)

S_0= N/A mph (Exhibit 13-12)

S = 48.8 mph (Exhibit 13-13)

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-526 EB*
Agency or Company	*Atkins*	From/To	*3025- PaulC WB Off to PaulC On*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2038 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*2633*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*9*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.957*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*60.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*60.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1529*	pc/h/ln
S	*60.0*	mph
D = v_p / S	*25.5*	pc/mi/ln
LOS	*C*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-526 EB*
Agency or Company	*Atkins*	From/To	*3025- PaulC WB Off to PaulC On*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*PM Peak*	Analysis Year	*2038 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*1917*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*8*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.962*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*60.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*60.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1108*	pc/h/ln
S	*60.0*	mph
D = v_p / S	*18.5*	pc/mi/ln
LOS	*C*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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F-3336

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-526 EB
Agency or Company	Atkins	Junction	3030-EB On from Paul Cantrell
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2038 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Number of Lanes, N: 2	☐ Yes ☐ On
☑ No ☐ Off	Acceleration Lane Length, L_A: 850	☑ No ☐ Off
L_{up} = ft	Deceleration Lane Length L_D:	L_{down} = ft
V_u = veh/h	Freeway Volume, V_F: 2633	V_D = veh/h
	Ramp Volume, V_R: 1755	
	Freeway Free-Flow Speed, S_{FF}: 60.0	
	Ramp Free-Flow Speed, S_{FR}: 45.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	2633	0.90	Level	9	0	0.957	1.00	3057
Ramp	1755	0.90	Level	17	0	0.922	1.00	2116
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 1.000 using Equation (Exhibit 13-6)

V_{12} = 3057 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	5173	Exhibit 13-8		Yes

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	5173	Exhibit 13-8	4600:All	Yes

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = 39.5 (pc/mi/ln)

LOS = F (Exhibit 13-2)

Speed Determination

M_S = 0.933 (Exibit 13-11)

S_R= 43.2 mph (Exhibit 13-11)

S_0= N/A mph (Exhibit 13-11)

S = 43.2 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-526 EB
Agency or Company	Atkins	Junction	3030-EB On from Paul Cantrell
Date Performed	4/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2038 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Number of Lanes, N: 2	☐ Yes ☐ On
☑ No ☐ Off	Acceleration Lane Length, L_A: 850	☑ No ☐ Off
L_{up} = ft	Deceleration Lane Length L_D:	L_{down} = ft
V_u = veh/h	Freeway Volume, V_F: 1917	V_D = veh/h
	Ramp Volume, V_R: 1538	
	Freeway Free-Flow Speed, S_{FF}: 60.0	
	Ramp Free-Flow Speed, S_{FR}: 45.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	1917	0.90	Level	8	0	0.962	1.00	2215
Ramp	1538	0.90	Level	17	0	0.922	1.00	1854
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 1.000 using Equation (Exhibit 13-6)

V_{12} = 2215 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	4069	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	4069	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = 31.0 (pc/mi/ln)

LOS = D (Exhibit 13-2)

Speed Determination

M_S = 0.473 (Exibit 13-11)

S_R= 51.5 mph (Exhibit 13-11)

S_0= N/A mph (Exhibit 13-11)

S = 51.5 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-526 EB*
Agency or Company	*Atkins*	From/To	*3040 - Paul Cantrell to Leeds*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2038 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*4388*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*9*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.957*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*60.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*60.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*2547*	pc/h/ln
S	*43.7*	mph
D = v_p / S	*58.3*	pc/mi/ln
LOS	*F*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-526 EB*
Agency or Company	*Atkins*	From/To	*3040 - Paul Cantrell to Leeds*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*PM Peak*	Analysis Year	*2038 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*3455*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*8*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.962*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*60.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*60.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1996*	pc/h/ln
S	*57.2*	mph
D = v_p / S	*34.9*	pc/mi/ln
LOS	*D*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-526 EB
Agency or Company	Atkins	Junction	3050-EB Off to Leeds
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2038 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Number of Lanes, N	2	Downstream Adj Ramp	
☐ Yes	☐ On	Acceleration Lane Length, L_A		☐ Yes	☐ On
☑ No	☐ Off	Deceleration Lane Length L_D	325	☑ No	☐ Off
L_{up} =	ft	Freeway Volume, V_F	4388	L_{down} =	ft
V_u =	veh/h	Ramp Volume, V_R	713	V_D =	veh/h
		Freeway Free-Flow Speed, S_{FF}	60.0		
		Ramp Free-Flow Speed, S_{FR}	45.0		

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	4388	0.90	Level	9	0	0.957	1.00	5095
Ramp	713	0.90	Level	8	0	0.962	1.00	824
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 1.000 using Equation (Exhibit 13-7)

V_{12} = 5095 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	5095	Exhibit 13-8	4600	Yes
$V_{FO} = V_F - V_R$	4271	Exhibit 13-8	4600	No
V_R	824	Exhibit 13-10	2100	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	5095	Exhibit 13-8	4400:All	Yes

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = 45.1 (pc/mi/ln)

LOS = F (Exhibit 13-2)

Speed Determination

D_s = 0.372 (Exhibit 13-12)

S_R= 53.3 mph (Exhibit 13-12)

S_0= N/A mph (Exhibit 13-12)

S = 53.3 mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-526 EB
Agency or Company	Atkins	Junction	3050-EB Off to Leeds
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2038 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Number of Lanes, N: 2	☐ Yes ☐ On
☑ No ☐ Off	Acceleration Lane Length, L_A:	☑ No ☐ Off
L_{up} = ft	Deceleration Lane Length L_D: 325	L_{down} = ft
V_u = veh/h	Freeway Volume, V_F: 3455	V_D = veh/h
	Ramp Volume, V_R: 337	
	Freeway Free-Flow Speed, S_{FF}: 60.0	
	Ramp Free-Flow Speed, S_{FR}: 45.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	3455	0.90	Level	8	0	0.962	1.00	3992
Ramp	337	0.90	Level	14	0	0.935	1.00	401
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 1.000 using Equation (Exhibit 13-7)

V_{12} = 3992 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	3992	Exhibit 13-8	4600	No
$V_{FO} = V_F - V_R$	3591	Exhibit 13-8	4600	No
V_R	401	Exhibit 13-10	2100	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	3992	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = 35.7 (pc/mi/ln)

LOS = E (Exhibit 13-2)

Speed Determination

D_s = 0.334 (Exhibit 13-12)

S_R= 54.0 mph (Exhibit 13-12)

S_0= N/A mph (Exhibit 13-12)

S = 54.0 mph (Exhibit 13-13)

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-526 EB*
Agency or Company	*Atkins*	From/To	*3055 - Leeds Off to Leeds On*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2038 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*3675*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*9*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.957*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*60.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*60.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*2134*	pc/h/ln
S	*54.8*	mph
D = v_p / S	*38.9*	pc/mi/ln
LOS	*E*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-526 EB*
Agency or Company	*Atkins*	From/To	*3055 - Leeds Off to Leeds On*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*PM Peak*	Analysis Year	*2038 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*3118*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*8*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.962*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*60.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*60.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1802*	pc/h/ln
S	*59.3*	mph
D = v_p / S	*30.4*	pc/mi/ln
LOS	*D*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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Navy Base ICTF

FREEWAY WEAVING WORKSHEET

General Information

Analyst	AJR
Agency/Company	Atkins
Date Performed	7/25/2014
Analysis Time Period	AM Peak

Site Information

Freeway/Dir of Travel	I-526 EB
Weaving Segment Location	3060 - Leeds to Dorchester
Analysis Year	2038 No Action

Project Description *Navy Base ICTF*

Inputs

Weaving configuration	One-Sided	Segment type	Freeway
Weaving number of lanes, N	3	Freeway minimum speed, S_{MIN}	15
Weaving segment length, L_S	2020ft	Freeway maximum capacity, C_{IFL}	2300
Freeway free-flow speed, FFS	60 mph	Terrain type	Level

Conversions to pc/h Under Base Conditions

	V (veh/h)	PHF	Truck (%)	RV (%)	E_T	E_R	f_{HV}	f_p	v (pc/h)
V_{FF}	3373	0.90	8	0	1.5	1.2	0.962	1.00	3898
V_{RF}	250	0.90	8	0	1.5	1.2	0.962	1.00	289
V_{FR}	302	0.90	12	0	1.5	1.2	0.943	1.00	356
V_{RR}	22	0.90	12	0	1.5	1.2	0.943	1.00	26
V_{NW}	3924							V =	4569
V_W	645								
VR	0.141								

Configuration Characteristics

Minimum maneuver lanes, N_{WL}	2 lc	Minimum weaving lane changes, LC_{MIN}	645 lc/h
Interchange density, ID	1.0 int/mi	Weaving lane changes, LC_W	898 lc/h
Minimum RF lane changes, LC_{RF}	1 lc/pc	Non-weaving lane changes, LC_{NW}	1325 lc/h
Minimum FR lane changes, LC_{FR}	1 lc/pc	Total lane changes, LC_{ALL}	2223 lc/h
Minimum RR lane changes, LC_{RR}	lc/pc	Non-weaving vehicle index, I_{NW}	793

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment flow rate, v	4569 pc/h	Weaving intensity factor, W	0.244
Weaving segment capacity, c_w	6211 veh/h	Weaving segment speed, S	48.5 mph
Weaving segment v/c ratio	0.707	Average weaving speed, S_W	51.2 mph
Weaving segment density, D	31.4 pc/mi/ln	Average non-weaving speed, S_{NW}	48.0 mph
Level of Service, LOS	D	Maximum weaving length, L_{MAX}	3944 ft

Notes

a. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments".
b. For volumes that exceed the weaving segment capacity, the level of service is "F".

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Navy Base ICTF

FREEWAY WEAVING WORKSHEET

General Information

Analyst	AJR
Agency/Company	Atkins
Date Performed	7/25/2014
Analysis Time Period	PM Peak

Site Information

Freeway/Dir of Travel	I-526 EB
Weaving Segment Location	3060 - Leeds to Dorchester
Analysis Year	2038 No Action

Project Description *Navy Base ICTF*

Inputs

Weaving configuration	One-Sided	Segment type	Freeway
Weaving number of lanes, N	3	Freeway minimum speed, S_{MIN}	15
Weaving segment length, L_S	2020ft	Freeway maximum capacity, C_{IFL}	2300
Freeway free-flow speed, FFS	60 mph	Terrain type	Level

Conversions to pc/h Under Base Conditions

	V (veh/h)	PHF	Truck (%)	RV (%)	E_T	E_R	f_{HV}	f_p	v (pc/h)
V_{FF}	2764	0.90	7	0	1.5	1.2	0.966	1.00	3179
V_{RF}	872	0.90	7	0	1.5	1.2	0.966	1.00	1003
V_{FR}	354	0.90	7	0	1.5	1.2	0.966	1.00	407
V_{RR}	112	0.90	7	0	1.5	1.2	0.966	1.00	129
V_{NW}	3308							V =	4718
V_W	1410								
VR	0.299								

Configuration Characteristics

Minimum maneuver lanes, N_{WL}	2 lc	Minimum weaving lane changes, LC_{MIN}	1410 lc/h
Interchange density, ID	1.0 int/mi	Weaving lane changes, LC_W	1663 lc/h
Minimum RF lane changes, LC_{RF}	1 lc/pc	Non-weaving lane changes, LC_{NW}	1198 lc/h
Minimum FR lane changes, LC_{FR}	1 lc/pc	Total lane changes, LC_{ALL}	2861 lc/h
Minimum RR lane changes, LC_{RR}	lc/pc	Non-weaving vehicle index, I_{NW}	668

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment flow rate, v	4718 pc/h	Weaving intensity factor, W	0.297
Weaving segment capacity, c_w	5878 veh/h	Weaving segment speed, S	44.3 mph
Weaving segment v/c ratio	0.776	Average weaving speed, S_W	49.7 mph
Weaving segment density, D	35.5 pc/mi/ln	Average non-weaving speed, S_{NW}	42.3 mph
Level of Service, LOS	E	Maximum weaving length, L_{MAX}	5572 ft

Notes

a. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments".
b. For volumes that exceed the weaving segment capacity, the level of service is "F".

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-526 EB*
Agency or Company	*Atkins*	From/To	*3065-Dorches Off to Dorches On*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2038 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*3623*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*9*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.957*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*60.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*60.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*2103*	pc/h/ln
S	*55.4*	mph
D = v_p / S	*38.0*	pc/mi/ln
LOS	*E*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-526 EB*
Agency or Company	*Atkins*	From/To	*3065-Dorches Off to Dorches On*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*PM Peak*	Analysis Year	*2038 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*3636*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*8*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.962*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*60.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*60.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*2101*	pc/h/ln
S	*55.4*	mph
D = v_p / S	*37.9*	pc/mi/ln
LOS	*E*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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Navy Base ICTF

FREEWAY WEAVING WORKSHEET

General Information

Analyst	AJR
Agency/Company	Atkins
Date Performed	7/25/2014
Analysis Time Period	AM Peak

Site Information

Freeway/Dir of Travel	I-526 EB
Weaving Segment Location	3070 - Dorchester to Montague
Analysis Year	2038 No Action

Project Description *Navy Base ICTF*

Inputs

Weaving configuration	One-Sided	Segment type	Freeway
Weaving number of lanes, N	3	Freeway minimum speed, S_{MIN}	15
Weaving segment length, L_S	1515ft	Freeway maximum capacity, C_{IFL}	2300
Freeway free-flow speed, FFS	60 mph	Terrain type	Level

Conversions to pc/h Under Base Conditions

	V (veh/h)	PHF	Truck (%)	RV (%)	E_T	E_R	f_{HV}	f_p	v (pc/h)
V_{FF}	2918	0.90	9	0	1.5	1.2	0.957	1.00	3388
V_{RF}	619	0.90	18	0	1.5	1.2	0.917	1.00	750
V_{FR}	705	0.90	10	0	1.5	1.2	0.952	1.00	823
V_{RR}	149	0.90	18	0	1.5	1.2	0.917	1.00	180
V_{NW}	3568							V =	5141
V_W	1573								
VR	0.306								

Configuration Characteristics

Minimum maneuver lanes, N_{WL}	2 lc	Minimum weaving lane changes, LC_{MIN}	1573 lc/h
Interchange density, ID	0.8 int/mi	Weaving lane changes, LC_W	1769 lc/h
Minimum RF lane changes, LC_{RF}	1 lc/pc	Non-weaving lane changes, LC_{NW}	978 lc/h
Minimum FR lane changes, LC_{FR}	1 lc/pc	Total lane changes, LC_{ALL}	2747 lc/h
Minimum RR lane changes, LC_{RR}	lc/pc	Non-weaving vehicle index, I_{NW}	432

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment flow rate, v	5141 pc/h	Weaving intensity factor, W	0.361
Weaving segment capacity, c_w	5696 veh/h	Weaving segment speed, S	42.5 mph
Weaving segment v/c ratio	0.864	Average weaving speed, S_W	48.1 mph
Weaving segment density, D	40.3 pc/mi/ln	Average non-weaving speed, S_{NW}	40.4 mph
Level of Service, LOS	E	Maximum weaving length, L_{MAX}	5648 ft

Notes

a. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments".
b. For volumes that exceed the weaving segment capacity, the level of service is "F".

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Navy Base ICTF

FREEWAY WEAVING WORKSHEET

General Information

Analyst	AJR
Agency/Company	Atkins
Date Performed	7/25/2014
Analysis Time Period	PM Peak

Site Information

Freeway/Dir of Travel	I-526 EB
Weaving Segment Location	3070 - Dorchester to Montague
Analysis Year	2038 No Action

Project Description *Navy Base ICTF*

Inputs

Weaving configuration	One-Sided	Segment type	Freeway
Weaving number of lanes, N	3	Freeway minimum speed, S_{MIN}	15
Weaving segment length, L_S	1515ft	Freeway maximum capacity, C_{IFL}	2300
Freeway free-flow speed, FFS	60 mph	Terrain type	Level

Conversions to pc/h Under Base Conditions

	V (veh/h)	PHF	Truck (%)	RV (%)	E_T	E_R	f_{HV}	f_p	v (pc/h)
V_{FF}	2742	0.90	8	0	1.5	1.2	0.962	1.00	3169
V_{RF}	873	0.90	10	0	1.5	1.2	0.952	1.00	1019
V_{FR}	894	0.90	8	0	1.5	1.2	0.962	1.00	1033
V_{RR}	285	0.90	10	0	1.5	1.2	0.952	1.00	333
V_{NW}	3502							V =	5554
V_W	2052								
VR	0.369								

Configuration Characteristics

Minimum maneuver lanes, N_{WL}	2 lc	Minimum weaving lane changes, LC_{MIN}	2052 lc/h
Interchange density, ID	0.8 int/mi	Weaving lane changes, LC_W	2248 lc/h
Minimum RF lane changes, LC_{RF}	1 lc/pc	Non-weaving lane changes, LC_{NW}	965 lc/h
Minimum FR lane changes, LC_{FR}	1 lc/pc	Total lane changes, LC_{ALL}	3213 lc/h
Minimum RR lane changes, LC_{RR}	lc/pc	Non-weaving vehicle index, I_{NW}	424

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment flow rate, v	5554 pc/h	Weaving intensity factor, W	0.409
Weaving segment capacity, c_w	5570 veh/h	Weaving segment speed, S	39.6 mph
Weaving segment v/c ratio	0.959	Average weaving speed, S_W	46.9 mph
Weaving segment density, D	46.7 pc/mi/ln	Average non-weaving speed, S_{NW}	36.3 mph
Level of Service, LOS	E	Maximum weaving length, L_{MAX}	6341 ft

Notes

a. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments".
b. For volumes that exceed the weaving segment capacity, the level of service is "F".

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-526 EB*
Agency or Company	*Atkins*	From/To	*3080-Montague to International*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2038 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*3537*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*9*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.957*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*60.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*60.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*2053*	pc/h/ln
S	*56.3*	mph
D = v_p / S	*36.5*	pc/mi/ln
LOS	*E*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-526 EB*
Agency or Company	*Atkins*	From/To	*3080-Montague to International*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*PM Peak*	Analysis Year	*2038 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*3615*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*8*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.962*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*60.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*60.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*2089*	pc/h/ln
S	*55.7*	mph
D = v_p / S	*37.5*	pc/mi/ln
LOS	*E*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-526 EB
Agency or Company	Atkins	Junction	3090-EB Off to InternationalWB
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2038 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Number of Lanes, N: 2	☐ Yes ☐ On
☑ No ☐ Off	Acceleration Lane Length, L_A:	☑ No ☐ Off
L_{up} = ft	Deceleration Lane Length L_D: 700	L_{down} = ft
V_u = veh/h	Freeway Volume, V_F: 3537	V_D = veh/h
	Ramp Volume, V_R: 952	
	Freeway Free-Flow Speed, S_{FF}: 60.0	
	Ramp Free-Flow Speed, S_{FR}: 25.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	3537	0.90	Level	9	0	0.957	1.00	4107
Ramp	952	0.90	Level	8	0	0.962	1.00	1100
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 1.000 using Equation (Exhibit 13-7)

V_{12} = 4107 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	4107	Exhibit 13-8	4600	No
$V_{FO} = V_F - V_R$	3007	Exhibit 13-8	4600	No
V_R	1100	Exhibit 13-10	1900	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	4107	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = 33.3 (pc/mi/ln)

LOS = D (Exhibit 13-2)

Speed Determination

D_s = 0.657 (Exhibit 13-12)

S_R= 48.2 mph (Exhibit 13-12)

S_0= N/A mph (Exhibit 13-12)

S = 48.2 mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-526 EB
Agency or Company	Atkins	Junction	3090-EB Off to InternationalWB
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2038 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Number of Lanes, N	2	Downstream Adj Ramp	
☐ Yes	☐ On	Acceleration Lane Length, L_A		☐ Yes	☐ On
☑ No	☐ Off	Deceleration Lane Length L_D	700	☑ No	☐ Off
L_{up} =	ft	Freeway Volume, V_F	3615	L_{down} =	ft
V_u =	veh/h	Ramp Volume, V_R	978	V_D =	veh/h
		Freeway Free-Flow Speed, S_{FF}	60.0		
		Ramp Free-Flow Speed, S_{FR}	25.0		

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	3615	0.90	Level	8	0	0.962	1.00	4177
Ramp	978	0.90	Level	6	0	0.971	1.00	1119
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 1.000 using Equation (Exhibit 13-7)

V_{12} = 4177 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	4177	Exhibit 13-8	4600	No
$V_{FO} = V_F - V_R$	3058	Exhibit 13-8	4600	No
V_R	1119	Exhibit 13-10	1900	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	4177	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = 33.9 (pc/mi/ln)

LOS = D (Exhibit 13-2)

Speed Determination

D_s = 0.659 (Exhibit 13-12)

S_R= 48.1 mph (Exhibit 13-12)

S_0= N/A mph (Exhibit 13-12)

S = 48.1 mph (Exhibit 13-13)

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-526 EB*
Agency or Company	*Atkins*	From/To	*3095- Inter WB Off to Inter On*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2038 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*2585*	veh/h	Peak-Hour Factor, PHF	*0.90*	
AADT		veh/day	%Trucks and Buses, P_T	*9*	
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*	
Peak-Hr Direction Prop, D			General Terrain:	*Level*	
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*	

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.957*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*60.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*60.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1501*	pc/h/ln
S	*60.0*	mph
D = v_p / S	*25.0*	pc/mi/ln
LOS	*C*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-526 EB*
Agency or Company	*Atkins*	From/To	*3095- Inter WB Off to Inter On*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*PM Peak*	Analysis Year	*2038 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*2637*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*8*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.962*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*60.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*60.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1524*	pc/h/ln
S	*60.0*	mph
D = v_p / S	*25.4*	pc/mi/ln
LOS	*C*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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Navy Base ICTF

FREEWAY WEAVING WORKSHEET

General Information

Analyst	AJR
Agency/Company	Atkins
Date Performed	7/25/2014
Analysis Time Period	AM Peak

Site Information

Freeway/Dir of Travel	I-526 EB
Weaving Segment Location	3100 - International to I-26
Analysis Year	2038 No Action

Project Description *Navy Base ICTF*

Inputs

Weaving configuration	One-Sided	Segment type	Freeway
Weaving number of lanes, N	3	Freeway minimum speed, S_{MIN}	15
Weaving segment length, L_S	2025ft	Freeway maximum capacity, C_{IFL}	2250
Freeway free-flow speed, FFS	55 mph	Terrain type	Level

Conversions to pc/h Under Base Conditions

	V (veh/h)	PHF	Truck (%)	RV (%)	E_T	E_R	f_{HV}	f_p	v (pc/h)
V_{FF}	1068	0.90	9	0	1.5	1.2	0.957	1.00	1240
V_{RF}	670	0.90	9	0	1.5	1.2	0.957	1.00	778
V_{FR}	1517	0.90	9	0	1.5	1.2	0.957	1.00	1761
V_{RR}	950	0.90	9	0	1.5	1.2	0.957	1.00	1103
V_{NW}	2343							V =	4882
V_W	2539								
VR	0.520								

Configuration Characteristics

Minimum maneuver lanes, N_{WL}	3 lc	Minimum weaving lane changes, LC_{MIN}	778 lc/h
Interchange density, ID	1.0 int/mi	Weaving lane changes, LC_W	1032 lc/h
Minimum RF lane changes, LC_{RF}	1 lc/pc	Non-weaving lane changes, LC_{NW}	1002 lc/h
Minimum FR lane changes, LC_{FR}	0 lc/pc	Total lane changes, LC_{ALL}	2034 lc/h
Minimum RR lane changes, LC_{RR}	lc/pc	Non-weaving vehicle index, I_{NW}	474

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment flow rate, v	4882 pc/h	Weaving intensity factor, W	0.227
Weaving segment capacity, c_w	5478 veh/h	Weaving segment speed, S	44.5 mph
Weaving segment v/c ratio	0.853	Average weaving speed, S_W	47.6 mph
Weaving segment density, D	36.6 pc/mi/ln	Average non-weaving speed, S_{NW}	41.6 mph
Level of Service, LOS	E	Maximum weaving length, L_{MAX}	6496 ft

Notes

a. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments".
b. For volumes that exceed the weaving segment capacity, the level of service is "F".

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Navy Base ICTF

FREEWAY WEAVING WORKSHEET

General Information

Analyst	AJR
Agency/Company	Atkins
Date Performed	7/25/2014
Analysis Time Period	PM Peak

Site Information

Freeway/Dir of Travel	I-526 EB
Weaving Segment Location	3100 - International to I-26
Analysis Year	2038 No Action

Project Description *Navy Base ICTF*

Inputs

Weaving configuration	One-Sided	Segment type	Freeway
Weaving number of lanes, N	3	Freeway minimum speed, S_{MIN}	15
Weaving segment length, L_S	2025ft	Freeway maximum capacity, C_{IFL}	2250
Freeway free-flow speed, FFS	55 mph	Terrain type	Level

Conversions to pc/h Under Base Conditions

	V (veh/h)	PHF	Truck (%)	RV (%)	E_T	E_R	f_{HV}	f_p	v (pc/h)
V_{FF}	1149	0.90	7	0	1.5	1.2	0.966	1.00	1321
V_{RF}	1051	0.90	7	0	1.5	1.2	0.966	1.00	1209
V_{FR}	1488	0.90	7	0	1.5	1.2	0.966	1.00	1711
V_{RR}	1363	0.90	7	0	1.5	1.2	0.966	1.00	1567
V_{NW}	2888							V =	5808
V_W	2920								
VR	0.503								

Configuration Characteristics

Minimum maneuver lanes, N_{WL}	3 lc	Minimum weaving lane changes, LC_{MIN}	lc/h
Interchange density, ID	1.0 int/mi	Weaving lane changes, LC_W	lc/h
Minimum RF lane changes, LC_{RF}	1 lc/pc	Non-weaving lane changes, LC_{NW}	lc/h
Minimum FR lane changes, LC_{FR}	0 lc/pc	Total lane changes, LC_{ALL}	lc/h
Minimum RR lane changes, LC_{RR}	lc/pc	Non-weaving vehicle index, I_{NW}	574

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment flow rate, v	5808 pc/h	Weaving intensity factor, W	
Weaving segment capacity, c_w	5577 veh/h	Weaving segment speed, S	mph
Weaving segment v/c ratio	1.006	Average weaving speed, S_W	mph
Weaving segment density, D	pc/mi/ln	Average non-weaving speed, S_{NW}	mph
Level of Service, LOS	F	Maximum weaving length, L_{MAX}	6293 ft

Notes

a. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments".
b. For volumes that exceed the weaving segment capacity, the level of service is "F".

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-526 EB*
Agency or Company	*Atkins*	From/To	*3105-I-26 Off to I-26 EB CD On*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2038 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*1738*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*17*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.922*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*55.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*55.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1048*	pc/h/ln
S	*55.0*	mph
D = v_p / S	*19.1*	pc/mi/ln
LOS	*C*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
S - Speed
V - Hourly volume
D - Density
v_p - Flow rate
FFS - Free-flow speed
LOS - Level of service
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-526 EB*
Agency or Company	*Atkins*	From/To	*3105-I-26 Off to I-26 EB CD On*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*PM Peak*	Analysis Year	*2038 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*2200*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*15*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.930*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*55.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*55.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1314*	pc/h/ln
S	*55.0*	mph
D = v_p / S	*23.9*	pc/mi/ln
LOS	*C*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-526 EB
Agency or Company	Atkins	Junction	3110-EB On from I-26 EB
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2038 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Number of Lanes, N: 2	☐ Yes ☐ On
☑ No ☐ Off	Acceleration Lane Length, L_A: 625	☑ No ☐ Off
L_{up} = ft	Deceleration Lane Length L_D:	L_{down} = ft
V_u = veh/h	Freeway Volume, V_F: 1738	V_D = veh/h
	Ramp Volume, V_R: 1479	
	Freeway Free-Flow Speed, S_{FF}: 55.0	
	Ramp Free-Flow Speed, S_{FR}: 25.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	1738	0.90	Level	17	0	0.922	1.00	2095
Ramp	1479	0.90	Level	51	0	0.797	1.00	2062
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 1.000 using Equation (Exhibit 13-6)

V_{12} = 2095 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	4157	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	4157	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = 33.0 (pc/mi/ln)

LOS = D (Exhibit 13-2)

Speed Determination

M_S = 0.539 (Exibit 13-11)

S_R= 48.0 mph (Exhibit 13-11)

S_0= N/A mph (Exhibit 13-11)

S = 48.0 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-526 EB
Agency or Company	Atkins	Junction	3110-EB On from I-26 EB
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2038 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Number of Lanes, N: 2	☐ Yes ☐ On
☑ No ☐ Off	Acceleration Lane Length, L_A: 625	☑ No ☐ Off
L_{up} = ft	Deceleration Lane Length L_D:	L_{down} = ft
V_u = veh/h	Freeway Volume, V_F: 2200	V_D = veh/h
	Ramp Volume, V_R: 1210	
	Freeway Free-Flow Speed, S_{FF}: 55.0	
	Ramp Free-Flow Speed, S_{FR}: 25.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	2200	0.90	Level	15	0	0.930	1.00	2628
Ramp	1210	0.90	Level	53	0	0.791	1.00	1701
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 1.000 using Equation (Exhibit 13-6)

V_{12} = 2628 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	4329	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	4329	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = 34.5 (pc/mi/ln)

LOS = D (Exhibit 13-2)

Speed Determination

M_S = 0.586 (Exibit 13-11)

S_R= 47.4 mph (Exhibit 13-11)

S_0= N/A mph (Exhibit 13-11)

S = 47.4 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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Navy Base ICTF

FREEWAY WEAVING WORKSHEET

General Information

Analyst	AJR
Agency/Company	Atkins
Date Performed	7/25/2014
Analysis Time Period	AM Peak

Site Information

Freeway/Dir of Travel	I-526 EB
Weaving Segment Location	3120 - I-26 WB to Rivers Ave
Analysis Year	2038 No Action

Project Description *Navy Base ICTF*

Inputs

Weaving configuration	One-Sided	Segment type	Freeway
Weaving number of lanes, N	3	Freeway minimum speed, S_{MIN}	15
Weaving segment length, L_S	1615ft	Freeway maximum capacity, C_{IFL}	2250
Freeway free-flow speed, FFS	55 mph	Terrain type	Level

Conversions to pc/h Under Base Conditions

	V (veh/h)	PHF	Truck (%)	RV (%)	E_T	E_R	f_{HV}	f_p	v (pc/h)
V_{FF}	3007	0.90	17	0	1.5	1.2	0.922	1.00	3625
V_{RF}	508	0.90	17	0	1.5	1.2	0.922	1.00	612
V_{FR}	210	0.90	17	0	1.5	1.2	0.922	1.00	253
V_{RR}	36	0.90	16	0	1.5	1.2	0.926	1.00	43
V_{NW}	3668							V =	4533
V_W	865								
VR	0.191								

Configuration Characteristics

Minimum maneuver lanes, N_{WL}	2 lc	Minimum weaving lane changes, LC_{MIN}	865 lc/h
Interchange density, ID	1.2 int/mi	Weaving lane changes, LC_W	1104 lc/h
Minimum RF lane changes, LC_{RF}	1 lc/pc	Non-weaving lane changes, LC_{NW}	1053 lc/h
Minimum FR lane changes, LC_{FR}	1 lc/pc	Total lane changes, LC_{ALL}	2157 lc/h
Minimum RR lane changes, LC_{RR}	lc/pc	Non-weaving vehicle index, I_{NW}	711

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment flow rate, v	4533 pc/h	Weaving intensity factor, W	0.284
Weaving segment capacity, c_w	5624 veh/h	Weaving segment speed, S	42.3 mph
Weaving segment v/c ratio	0.743	Average weaving speed, S_W	46.2 mph
Weaving segment density, D	35.7 pc/mi/ln	Average non-weaving speed, S_{NW}	41.5 mph
Level of Service, LOS	E	Maximum weaving length, L_{MAX}	4443 ft

Notes

a. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments".
b. For volumes that exceed the weaving segment capacity, the level of service is "F".

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Navy Base ICTF

FREEWAY WEAVING WORKSHEET

General Information

Analyst	AJR
Agency/Company	Atkins
Date Performed	7/25/2014
Analysis Time Period	PM Peak

Site Information

Freeway/Dir of Travel	I-526 EB
Weaving Segment Location	3120 - I-26 WB to Rivers Ave
Analysis Year	2038 No Action

Project Description *Navy Base ICTF*

Inputs

Weaving configuration	One-Sided	Segment type	Freeway
Weaving number of lanes, N	3	Freeway minimum speed, S_{MIN}	15
Weaving segment length, L_S	1615ft	Freeway maximum capacity, C_{IFL}	2250
Freeway free-flow speed, FFS	55 mph	Terrain type	Level

Conversions to pc/h Under Base Conditions

	V (veh/h)	PHF	Truck (%)	RV (%)	E_T	E_R	f_{HV}	f_p	v (pc/h)
V_{FF}	3058	0.90	15	0	1.5	1.2	0.930	1.00	3653
V_{RF}	439	0.90	15	0	1.5	1.2	0.930	1.00	524
V_{FR}	352	0.90	15	0	1.5	1.2	0.930	1.00	420
V_{RR}	51	0.90	8	0	1.5	1.2	0.962	1.00	59
V_{NW}	3712							V =	4656
V_W	944								
VR	0.203								

Configuration Characteristics

Minimum maneuver lanes, N_{WL}	2 lc	Minimum weaving lane changes, LC_{MIN}	944 lc/h
Interchange density, ID	1.2 int/mi	Weaving lane changes, LC_W	1183 lc/h
Minimum RF lane changes, LC_{RF}	1 lc/pc	Non-weaving lane changes, LC_{NW}	1062 lc/h
Minimum FR lane changes, LC_{FR}	1 lc/pc	Total lane changes, LC_{ALL}	2245 lc/h
Minimum RR lane changes, LC_{RR}	lc/pc	Non-weaving vehicle index, I_{NW}	719

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment flow rate, v	4656 pc/h	Weaving intensity factor, W	0.293
Weaving segment capacity, c_w	5648 veh/h	Weaving segment speed, S	41.7 mph
Weaving segment v/c ratio	0.767	Average weaving speed, S_W	45.9 mph
Weaving segment density, D	37.2 pc/mi/ln	Average non-weaving speed, S_{NW}	40.8 mph
Level of Service, LOS	E	Maximum weaving length, L_{MAX}	4564 ft

Notes

a. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments".
b. For volumes that exceed the weaving segment capacity, the level of service is "F".

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-526 EB
Agency or Company	Atkins	Junction	3130-EB Off to Rivers NB
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2038 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Number of Lanes, N	2	Downstream Adj Ramp	
☐ Yes	☐ On	Acceleration Lane Length, L_A		☐ Yes	☐ On
☑ No	☐ Off	Deceleration Lane Length L_D	800	☑ No	☐ Off
L_{up} =	ft	Freeway Volume, V_F	3515	L_{down} =	ft
		Ramp Volume, V_R	163		
V_u =	veh/h	Freeway Free-Flow Speed, S_{FF}	55.0	V_D =	veh/h
		Ramp Free-Flow Speed, S_{FR}	25.0		

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	3515	0.90	Level	17	0	0.922	1.00	4238
Ramp	163	0.90	Level	23	0	0.897	1.00	202
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 1.000 using Equation (Exhibit 13-7)

V_{12} = 4238 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	4238	Exhibit 13-8	4500	No
$V_{FO} = V_F - V_R$	4036	Exhibit 13-8	4500	No
V_R	202	Exhibit 13-10	1900	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	4238	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = 33.5 (pc/mi/ln)

LOS = D (Exhibit 13-2)

Speed Determination

D_s = 0.576 (Exhibit 13-12)

S_R= 47.5 mph (Exhibit 13-12)

S_0= N/A mph (Exhibit 13-12)

S = 47.5 mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-526 EB
Agency or Company	Atkins	Junction	3130-EB Off to Rivers NB
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2038 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Number of Lanes, N	2	Downstream Adj Ramp	
☐ Yes	☐ On	Acceleration Lane Length, L_A		☐ Yes	☐ On
☑ No	☐ Off	Deceleration Lane Length L_D	800	☑ No	☐ Off
L_{up} =	ft	Freeway Volume, V_F	3497	L_{down} =	ft
		Ramp Volume, V_R	332		
		Freeway Free-Flow Speed, S_{FF}	55.0		
V_u =	veh/h	Ramp Free-Flow Speed, S_{FR}	25.0	V_D =	veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	3497	0.90	Level	15	0	0.930	1.00	4177
Ramp	332	0.90	Level	9	0	0.957	1.00	385
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 1.000 using Equation (Exhibit 13-7)

V_{12} = 4177 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	4177	Exhibit 13-8	4500	No
$V_{FO} = V_F - V_R$	3792	Exhibit 13-8	4500	No
V_R	385	Exhibit 13-10	1900	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	4177	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = 33.0 (pc/mi/ln)

LOS = D (Exhibit 13-2)

Speed Determination

D_s = 0.593 (Exhibit 13-12)

S_R= 47.3 mph (Exhibit 13-12)

S_0= N/A mph (Exhibit 13-12)

S = 47.3 mph (Exhibit 13-13)

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-526 EB*
Agency or Company	*Atkins*	From/To	*3135-RiversNB Off to Rivers On*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2038 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*3352*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*17*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.922*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*55.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*55.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*2021*	pc/h/ln
S	*53.8*	mph
D = v_p / S	*37.6*	pc/mi/ln
LOS	*E*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-526 EB*
Agency or Company	*Atkins*	From/To	*3135-RiversNB Off to Rivers On*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*PM Peak*	Analysis Year	*2038 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*3165*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*15*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.930*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*55.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*55.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1890*	pc/h/ln
S	*54.8*	mph
D = v_p / S	*34.5*	pc/mi/ln
LOS	*D*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-526 EB
Agency or Company	Atkins	Junction	3140-EB On from Rivers
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2038 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Number of Lanes, N: 2	☐ Yes ☐ On
☑ No ☐ Off	Acceleration Lane Length, L_A: 825	☑ No ☐ Off
L_{up} = ft	Deceleration Lane Length L_D:	L_{down} = ft
V_u = veh/h	Freeway Volume, V_F: 3352	V_D = veh/h
	Ramp Volume, V_R: 578	
	Freeway Free-Flow Speed, S_{FF}: 55.0	
	Ramp Free-Flow Speed, S_{FR}: 45.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	3352	0.90	Level	17	0	0.922	1.00	4041
Ramp	578	0.90	Level	9	0	0.957	1.00	671
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 1.000 using Equation (Exhibit 13-6)

V_{12} = 4041 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	4712	Exhibit 13-8		Yes

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	4712	Exhibit 13-8	4600:All	Yes

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = 36.7 (pc/mi/ln)

LOS = F (Exhibit 13-2)

Speed Determination

M_S = 0.681 (Exibit 13-11)

S_R= 46.2 mph (Exhibit 13-11)

S_0= N/A mph (Exhibit 13-11)

S = 46.2 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-526 EB
Agency or Company	Atkins	Junction	3140-EB On from Rivers
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2038 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Number of Lanes, N: 2	☐ Yes ☐ On
☑ No ☐ Off	Acceleration Lane Length, L_A: 825	☑ No ☐ Off
L_{up} = ft	Deceleration Lane Length L_D:	L_{down} = ft
V_u = veh/h	Freeway Volume, V_F: 3165	V_D = veh/h
	Ramp Volume, V_R: 550	
	Freeway Free-Flow Speed, S_{FF}: 55.0	
	Ramp Free-Flow Speed, S_{FR}: 45.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	3165	0.90	Level	15	0	0.930	1.00	3780
Ramp	550	0.90	Level	8	0	0.962	1.00	636
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 1.000 using Equation (Exhibit 13-6)

V_{12} = 3780 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	4416	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	4416	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = 34.5 (pc/mi/ln)

LOS = D (Exhibit 13-2)

Speed Determination

M_S = 0.570 (Exibit 13-11)

S_R= 47.6 mph (Exhibit 13-11)

S_0= N/A mph (Exhibit 13-11)

S = 47.6 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-526 EB*
Agency or Company	*Atkins*	From/To	*3150-Rivers to Rhett*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2038 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*3930*	veh/h	Peak-Hour Factor, PHF	*0.90*	
AADT		veh/day	%Trucks and Buses, P_T	*17*	
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*	
Peak-Hr Direction Prop, D			General Terrain:	*Level*	
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*	

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.922*

Speed Inputs			Calc Speed Adj and FFS		
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f_{LW}		mph
Number of Lanes, N	*2*		f_{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	*60.0*	mph	FFS	*60.0*	mph
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures			Design (N)	
Operational (LOS)			Design (N)	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*2369*	pc/h/ln	Design LOS	
			v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h/ln
S	*49.3*	mph	S	mph
D = v_p / S	*48.1*	pc/mi/ln	D = v_p / S	pc/mi/ln
LOS	*F*		Required Number of Lanes, N	

Glossary		Factor Location	
N - Number of lanes	S - Speed	E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
V - Hourly volume	D - Density	E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 11-18	TRD - Page 11-11
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 11-2, 11-3	
DDHV - Directional design hour volume			

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-526 EB*
Agency or Company	*Atkins*	From/To	*3150-Rivers to Rhett*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*PM Peak*	Analysis Year	*2038 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*3715*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*15*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.930*

Speed Inputs			Calc Speed Adj and FFS		
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f_{LW}		mph
Number of Lanes, N	*2*		f_{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	*60.0*	mph	FFS	*60.0*	mph
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures			Design (N)	
Operational (LOS)			Design (N)	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*2219*	pc/h/ln	Design LOS	
			v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h/ln
S	*53.0*	mph	S	mph
D = v_p / S	*41.8*	pc/mi/ln	D = v_p / S	pc/mi/ln
LOS	*E*		Required Number of Lanes, N	

Glossary		Factor Location	
N - Number of lanes	S - Speed	E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
V - Hourly volume	D - Density	E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 11-18	TRD - Page 11-11
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 11-2, 11-3	
DDHV - Directional design hour volume			

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-526 EB
Agency or Company	Atkins	Junction	3160-EB Off to Rhett
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2038 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Number of Lanes, N	2	Downstream Adj Ramp	
☐ Yes	☐ On	Acceleration Lane Length, L_A		☐ Yes	☐ On
☑ No	☐ Off	Deceleration Lane Length L_D	225	☑ No	☐ Off
L_{up} =	ft	Freeway Volume, V_F	3930	L_{down} =	ft
		Ramp Volume, V_R	503		
		Freeway Free-Flow Speed, S_{FF}	60.0		
V_u =	veh/h	Ramp Free-Flow Speed, S_{FR}	45.0	V_D =	veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	3930	0.90	Level	17	0	0.922	1.00	4738
Ramp	503	0.90	Level	6	0	0.971	1.00	576
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 1.000 using Equation (Exhibit 13-7)

V_{12} = 4738 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	4738	Exhibit 13-8	4600	Yes
$V_{FO} = V_F - V_R$	4162	Exhibit 13-8	4600	No
V_R	576	Exhibit 13-10	2100	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	4738	Exhibit 13-8	4400:All	Yes

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = 43.0 (pc/mi/ln)

LOS = F (Exhibit 13-2)

Speed Determination

D_s = 0.350 (Exhibit 13-12)

S_R= 53.7 mph (Exhibit 13-12)

S_0= N/A mph (Exhibit 13-12)

S = 53.7 mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-526 EB
Agency or Company	Atkins	Junction	3160-EB Off to Rhett
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2038 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Number of Lanes, N	2	Downstream Adj Ramp	
☐ Yes	☐ On	Acceleration Lane Length, L_A		☐ Yes	☐ On
☑ No	☐ Off	Deceleration Lane Length L_D	225	☑ No	☐ Off
L_{up} =	ft	Freeway Volume, V_F	3715	L_{down} =	ft
		Ramp Volume, V_R	730		
V_u =	veh/h	Freeway Free-Flow Speed, S_{FF}	60.0	V_D =	veh/h
		Ramp Free-Flow Speed, S_{FR}	45.0		

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	3715	0.90	Level	15	0	0.930	1.00	4437
Ramp	730	0.90	Level	4	0	0.980	1.00	827
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 1.000 using Equation (Exhibit 13-7)

V_{12} = 4437 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	4437	Exhibit 13-8	4600	No
$V_{FO} = V_F - V_R$	3610	Exhibit 13-8	4600	No
V_R	827	Exhibit 13-10	2100	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	4437	Exhibit 13-8	4400:All	Yes

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = 40.4 (pc/mi/ln)

LOS = E (Exhibit 13-2)

Speed Determination

D_s = 0.372 (Exhibit 13-12)

S_R= 53.3 mph (Exhibit 13-12)

S_0= N/A mph (Exhibit 13-12)

S = 53.3 mph (Exhibit 13-13)

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*3427*	Highway/Direction of Travel	*I-526 EB*
Agency or Company	*Atkins*	From/To	*3165 - Rhett Off to Rhett On*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2038 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs				
Volume, V	*3427*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*17*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments			
f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.922*

Speed Inputs			Calc Speed Adj and FFS		
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f_{LW}		mph
Number of Lanes, N	*2*		f_{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	*60.0*	mph	FFS	*60.0*	mph
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures			Design (N)	
Operational (LOS)			Design (N)	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*2066*	pc/h/ln	Design LOS	
			v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h/ln
S	*56.1*	mph	S	mph
D = v_p / S	*36.9*	pc/mi/ln	D = v_p / S	pc/mi/ln
LOS	*E*		Required Number of Lanes, N	

Glossary		Factor Location	
N - Number of lanes	S - Speed	E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
V - Hourly volume	D - Density	E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 11-18	TRD - Page 11-11
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 11-2, 11-3	
DDHV - Directional design hour volume			

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-526 EB*
Agency or Company	*Atkins*	From/To	*3165 - Rhett Off to Rhett On*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*PM Peak*	Analysis Year	*2038 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs				
Volume, V	*2985*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*15*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.930*

Speed Inputs			Calc Speed Adj and FFS		
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f_{LW}		mph
Number of Lanes, N	*2*		f_{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	*60.0*	mph	FFS	*60.0*	mph
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures			Design (N)	
Operational (LOS)			Design (N)	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1783*	pc/h/ln	Design LOS	
S	*59.4*	mph	v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h/ln
D = v_p / S	*30.0*	pc/mi/ln	S	mph
LOS	*D*		D = v_p / S	pc/mi/ln
			Required Number of Lanes, N	

Glossary		Factor Location	
N - Number of lanes	S - Speed	E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
V - Hourly volume	D - Density	E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 11-18	TRD - Page 11-11
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 11-2, 11-3	
DDHV - Directional design hour volume			

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Navy Base ICTF

FREEWAY WEAVING WORKSHEET

General Information

Analyst	AJR
Agency/Company	Atkins
Date Performed	7/25/2014
Analysis Time Period	AM Peak

Site Information

Freeway/Dir of Travel	I-526 EB
Weaving Segment Location	3170 - Rhett to Virginia
Analysis Year	2038 No Action

Project Description *Navy Base ICTF*

Inputs

Weaving configuration	One-Sided	Segment type	Freeway
Weaving number of lanes, N	3	Freeway minimum speed, S_{MIN}	15
Weaving segment length, L_S	1090ft	Freeway maximum capacity, C_{IFL}	2300
Freeway free-flow speed, FFS	60 mph	Terrain type	Level

Conversions to pc/h Under Base Conditions

	V (veh/h)	PHF	Truck (%)	RV (%)	E_T	E_R	f_{HV}	f_p	v (pc/h)
V_{FF}	2937	0.90	15	0	1.5	1.2	0.930	1.00	3508
V_{RF}	1219	0.90	15	0	1.5	1.2	0.930	1.00	1456
V_{FR}	490	0.90	15	0	1.5	1.2	0.930	1.00	585
V_{RR}	204	0.90	15	0	1.5	1.2	0.930	1.00	244
V_{NW}	3752							V =	5793
V_W	2041								
VR	0.352								

Configuration Characteristics

Minimum maneuver lanes, N_{WL}	2 lc	Minimum weaving lane changes, LC_{MIN}	lc/h
Interchange density, ID	0.7 int/mi	Weaving lane changes, LC_W	lc/h
Minimum RF lane changes, LC_{RF}	1 lc/pc	Non-weaving lane changes, LC_{NW}	lc/h
Minimum FR lane changes, LC_{FR}	1 lc/pc	Total lane changes, LC_{ALL}	lc/h
Minimum RR lane changes, LC_{RR}	lc/pc	Non-weaving vehicle index, I_{NW}	285

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment flow rate, v	5793 pc/h	Weaving intensity factor, W	
Weaving segment capacity, c_w	5339 veh/h	Weaving segment speed, S	mph
Weaving segment v/c ratio	1.009	Average weaving speed, S_W	mph
Weaving segment density, D	pc/mi/ln	Average non-weaving speed, S_{NW}	mph
Level of Service, LOS	F	Maximum weaving length, L_{MAX}	6152 ft

Notes

a. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments".
b. For volumes that exceed the weaving segment capacity, the level of service is "F".

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Navy Base ICTF

FREEWAY WEAVING WORKSHEET

General Information

Analyst	AJR
Agency/Company	Atkins
Date Performed	7/25/2014
Analysis Time Period	PM Peak

Site Information

Freeway/Dir of Travel	I-526 EB
Weaving Segment Location	3170 - Rhett to Virginia
Analysis Year	2038 No Action

Project Description *Navy Base ICTF*

Inputs

Weaving configuration	One-Sided	Segment type	Freeway
Weaving number of lanes, N	3	Freeway minimum speed, S_{MIN}	15
Weaving segment length, L_S	1090ft	Freeway maximum capacity, C_{IFL}	2300
Freeway free-flow speed, FFS	60 mph	Terrain type	Level

Conversions to pc/h Under Base Conditions

	V (veh/h)	PHF	Truck (%)	RV (%)	E_T	E_R	f_{HV}	f_p	v (pc/h)
V_{FF}	2844	0.90	14	0	1.5	1.2	0.935	1.00	3381
V_{RF}	1063	0.90	14	0	1.5	1.2	0.935	1.00	1264
V_{FR}	141	0.90	46	0	1.5	1.2	0.813	1.00	193
V_{RR}	52	0.90	46	0	1.5	1.2	0.813	1.00	71
V_{NW}	3452							V =	4909
V_W	1457								
VR	0.297								

Configuration Characteristics

Minimum maneuver lanes, N_{WL}	2 lc	Minimum weaving lane changes, LC_{MIN}	1457 lc/h
Interchange density, ID	0.7 int/mi	Weaving lane changes, LC_W	1608 lc/h
Minimum RF lane changes, LC_{RF}	1 lc/pc	Non-weaving lane changes, LC_{NW}	724 lc/h
Minimum FR lane changes, LC_{FR}	1 lc/pc	Total lane changes, LC_{ALL}	2332 lc/h
Minimum RR lane changes, LC_{RR}	lc/pc	Non-weaving vehicle index, I_{NW}	263

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment flow rate, v	4909 pc/h	Weaving intensity factor, W	0.412
Weaving segment capacity, c_w	5493 veh/h	Weaving segment speed, S	43.1 mph
Weaving segment v/c ratio	0.835	Average weaving speed, S_W	46.9 mph
Weaving segment density, D	38.0 pc/mi/ln	Average non-weaving speed, S_{NW}	41.7 mph
Level of Service, LOS	E	Maximum weaving length, L_{MAX}	5550 ft

Notes

a. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments".
b. For volumes that exceed the weaving segment capacity, the level of service is "F".

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-526 EB*
Agency or Company	*Atkins*	From/To	*3180-Virginia to ClementsFerry*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2038 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*4156*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*13*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.939*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*60.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*60.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*2459*	pc/h/ln
S	*46.6*	mph
D = v_p / S	*52.8*	pc/mi/ln
LOS	*F*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-526 EB*
Agency or Company	*Atkins*	From/To	*3180-Virginia to ClementsFerry*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*PM Peak*	Analysis Year	*2038 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*3907*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*12*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.943*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*60.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*60.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*2301*	pc/h/ln
S	*51.1*	mph
D = v_p / S	*45.1*	pc/mi/ln
LOS	*F*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-526 EB
Agency or Company	Atkins	Junction	3190-EB Off to ClementsFerrySB
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2038 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Number of Lanes, N	2	Downstream Adj Ramp	
☐ Yes	☐ On	Acceleration Lane Length, L_A		☐ Yes	☐ On
☑ No	☐ Off	Deceleration Lane Length L_D	250	☑ No	☐ Off
L_{up} =	ft	Freeway Volume, V_F	4156	L_{down} =	ft
		Ramp Volume, V_R	423		
		Freeway Free-Flow Speed, S_{FF}	60.0		
V_u =	veh/h	Ramp Free-Flow Speed, S_{FR}	45.0	V_D =	veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	4156	0.90	Level	13	0	0.939	1.00	4918
Ramp	423	0.90	Level	9	0	0.957	1.00	491
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 1.000 using Equation (Exhibit 13-7)

V_{12} = 4918 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	4918	Exhibit 13-8	4600	Yes
$V_{FO} = V_F - V_R$	4427	Exhibit 13-8	4600	No
V_R	491	Exhibit 13-10	2100	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	4918	Exhibit 13-8	4400:All	Yes

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = 44.3 (pc/mi/ln)

LOS = F (Exhibit 13-2)

Speed Determination

D_s = 0.342 (Exhibit 13-12)

S_R= 53.8 mph (Exhibit 13-12)

S_0= N/A mph (Exhibit 13-12)

S = 53.8 mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-526 EB
Agency or Company	Atkins	Junction	3190-EB Off to ClementsFerrySB
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2038 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Number of Lanes, N	2	Downstream Adj Ramp	
☐ Yes	☐ On	Acceleration Lane Length, L_A		☐ Yes	☐ On
☑ No	☐ Off	Deceleration Lane Length L_D	250	☑ No	☐ Off
L_{up} =	ft	Freeway Volume, V_F	3907	L_{down} =	ft
V_u =	veh/h	Ramp Volume, V_R	219	V_D =	veh/h
		Freeway Free-Flow Speed, S_{FF}	60.0		
		Ramp Free-Flow Speed, S_{FR}	45.0		

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	3907	0.90	Level	12	0	0.943	1.00	4602
Ramp	219	0.90	Level	15	0	0.930	1.00	262
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 1.000 using Equation (Exhibit 13-7)

V_{12} = 4602 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	4602	Exhibit 13-8	4600	Yes
$V_{FO} = V_F - V_R$	4340	Exhibit 13-8	4600	No
V_R	262	Exhibit 13-10	2100	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	4602	Exhibit 13-8	4400:All	Yes

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = 41.6 (pc/mi/ln)

LOS = F (Exhibit 13-2)

Speed Determination

D_s = 0.322 (Exhibit 13-12)

S_R= 54.2 mph (Exhibit 13-12)

S_0= N/A mph (Exhibit 13-12)

S = 54.2 mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-526 EB
Agency or Company	Atkins	Junction	3200-EB Off to ClementsFerryNB
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2038 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Number of Lanes, N	2	Downstream Adj Ramp	
☐ Yes	☐ On	Acceleration Lane Length, L_A		☐ Yes	☐ On
☑ No	☐ Off	Deceleration Lane Length L_D	900	☑ No	☐ Off
L_{up} =	ft	Freeway Volume, V_F	3733	L_{down} =	ft
V_u =	veh/h	Ramp Volume, V_R	980	V_D =	veh/h
		Freeway Free-Flow Speed, S_{FF}	60.0		
		Ramp Free-Flow Speed, S_{FR}	25.0		

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	3733	0.90	Level	13	0	0.939	1.00	4417
Ramp	980	0.90	Level	20	0	0.909	1.00	1198
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 1.000 using Equation (Exhibit 13-7)

V_{12} = 4417 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	4417	Exhibit 13-8	4600	No
$V_{FO} = V_F - V_R$	3219	Exhibit 13-8	4600	No
V_R	1198	Exhibit 13-10	1900	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	4417	Exhibit 13-8	4400:All	Yes

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = 34.1 (pc/mi/ln)

LOS = D (Exhibit 13-2)

Speed Determination

D_s = 0.666 (Exhibit 13-12)

S_R= 48.0 mph (Exhibit 13-12)

S_0= N/A mph (Exhibit 13-12)

S = 48.0 mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-526 EB
Agency or Company	Atkins	Junction	3200-EB Off to ClementsFerryNB
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2038 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Number of Lanes, N	2	Downstream Adj Ramp	
☐ Yes	☐ On	Acceleration Lane Length, L_A		☐ Yes	☐ On
☑ No	☐ Off	Deceleration Lane Length L_D	900	☑ No	☐ Off
L_{up} =	ft	Freeway Volume, V_F	3688	L_{down} =	ft
		Ramp Volume, V_R	899		
		Freeway Free-Flow Speed, S_{FF}	60.0		
V_u =	veh/h	Ramp Free-Flow Speed, S_{FR}	25.0	V_D =	veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	3688	0.90	Level	12	0	0.943	1.00	4344
Ramp	899	0.90	Level	19	0	0.913	1.00	1094
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 1.000 using Equation (Exhibit 13-7)

V_{12} = 4344 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	4344	Exhibit 13-8	4600	No
$V_{FO} = V_F - V_R$	3250	Exhibit 13-8	4600	No
V_R	1094	Exhibit 13-10	1900	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	4344	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = 33.5 (pc/mi/ln)

LOS = D (Exhibit 13-2)

Speed Determination

D_s = 0.656 (Exhibit 13-12)

S_R= 48.2 mph (Exhibit 13-12)

S_0= N/A mph (Exhibit 13-12)

S = 48.2 mph (Exhibit 13-13)

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-526 EB*
Agency or Company	*Atkins*	From/To	*3205-ClemFerry NB Off to NB On*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2038 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*2753*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*13*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.939*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*60.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*60.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1629*	pc/h/ln
S	*60.0*	mph
D = v_p / S	*27.2*	pc/mi/ln
LOS	*D*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-526 EB*
Agency or Company	*Atkins*	From/To	*3205-ClemFerry NB Off to NB On*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*PM Peak*	Analysis Year	*2038 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*2789*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*12*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.943*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*60.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*60.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1642*	pc/h/ln
S	*60.0*	mph
D = v_p / S	*27.4*	pc/mi/ln
LOS	*D*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-526 EB
Agency or Company	Atkins	Junction	3210-EB On from Clements Ferry
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2038 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Number of Lanes, N: 2	☐ Yes ☐ On
☑ No ☐ Off	Acceleration Lane Length, L_A: 1025	☑ No ☐ Off
L_{up} = ft	Deceleration Lane Length L_D:	L_{down} = ft
V_u = veh/h	Freeway Volume, V_F: 2753	V_D = veh/h
	Ramp Volume, V_R: 454	
	Freeway Free-Flow Speed, S_{FF}: 60.0	
	Ramp Free-Flow Speed, S_{FR}: 45.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	2753	0.90	Level	13	0	0.939	1.00	3258
Ramp	454	0.90	Level	11	0	0.948	1.00	532
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 1.000 using Equation (Exhibit 13-6)

V_{12} = 3258 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	3790	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	3790	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = 28.4 (pc/mi/ln)

LOS = D (Exhibit 13-2)

Speed Determination

M_S = 0.401 (Exibit 13-11)

S_R= 52.8 mph (Exhibit 13-11)

S_0= N/A mph (Exhibit 13-11)

S = 52.8 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-526 EB
Agency or Company	Atkins	Junction	3210-EB On from Clements Ferry
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2038 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Number of Lanes, N: 2	☐ Yes ☐ On
☑ No ☐ Off	Acceleration Lane Length, L_A: 1025	☑ No ☐ Off
L_{up} = ft	Deceleration Lane Length L_D:	L_{down} = ft
V_u = veh/h	Freeway Volume, V_F: 2789	V_D = veh/h
	Ramp Volume, V_R: 696	
	Freeway Free-Flow Speed, S_{FF}: 60.0	
	Ramp Free-Flow Speed, S_{FR}: 45.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	2789	0.90	Level	12	0	0.943	1.00	3285
Ramp	696	0.90	Level	6	0	0.971	1.00	797
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 1.000 using Equation (Exhibit 13-6)

V_{12} = 3285 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	4082	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	4082	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = 30.5 (pc/mi/ln)

LOS = D (Exhibit 13-2)

Speed Determination

M_S = 0.460 (Exibit 13-11)

S_R= 51.7 mph (Exhibit 13-11)

S_0= N/A mph (Exhibit 13-11)

S = 51.7 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-526 EB*
Agency or Company	*Atkins*	From/To	*3220-ClementsFerrytoRiversLand*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2038 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*3207*	veh/h	Peak-Hour Factor, PHF	*0.90*	
AADT		veh/day	%Trucks and Buses, P_T	*11*	
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*	
Peak-Hr Direction Prop, D			General Terrain:	*Level*	
DDHV = AADT x K x D		veh/h	Grade % Length	*mi*	
			Up/Down %		

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.948*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*60.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*60.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1880*	pc/h/ln
S	*58.6*	mph
D = v_p / S	*32.1*	pc/mi/ln
LOS	*D*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-526 EB*
Agency or Company	*Atkins*	From/To	*3220-ClementsFerrytoRiversLand*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*PM Peak*	Analysis Year	*2038 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*3485*	veh/h	Peak-Hour Factor, PHF	*0.90*	
AADT		veh/day	%Trucks and Buses, P_T	*9*	
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*	
Peak-Hr Direction Prop, D			General Terrain:	*Level*	
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*	

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.957*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*60.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*60.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*2023*	pc/h/ln
S	*56.8*	mph
D = v_p / S	*35.6*	pc/mi/ln
LOS	*E*	

Design (N)

Design (N)

Design LOS	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h/ln
S	mph
D = v_p / S	pc/mi/ln
Required Number of Lanes, N	

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-526 EB
Agency or Company	Atkins	Junction	3230-EB Off to River Landing
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2038 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Number of Lanes, N	2	Downstream Adj Ramp	
☐ Yes	☐ On	Acceleration Lane Length, L_A		☐ Yes	☐ On
☑ No	☐ Off	Deceleration Lane Length L_D	800	☑ No	☐ Off
L_{up} =	ft	Freeway Volume, V_F	3207	L_{down} =	ft
		Ramp Volume, V_R	791		
V_u =	veh/h	Freeway Free-Flow Speed, S_{FF}	65.0	V_D =	veh/h
		Ramp Free-Flow Speed, S_{FR}	45.0		

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	3207	0.90	Level	11	0	0.948	1.00	3759
Ramp	791	0.90	Level	4	0	0.980	1.00	896
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 1.000 using Equation (Exhibit 13-7)

V_{12} = 3759 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	3759	Exhibit 13-8	4700	No
$V_{FO} = V_F - V_R$	2863	Exhibit 13-8	4700	No
V_R	896	Exhibit 13-10	2100	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	3759	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = 29.4 (pc/mi/ln)

LOS = D (Exhibit 13-2)

Speed Determination

D_s = 0.379 (Exhibit 13-12)

S_R= 56.3 mph (Exhibit 13-12)

S_0= N/A mph (Exhibit 13-12)

S = 56.3 mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-526 EB
Agency or Company	Atkins	Junction	3230-EB Off to River Landing
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2038 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Number of Lanes, N: 2	☐ Yes ☐ On
☑ No ☐ Off	Acceleration Lane Length, L_A:	☑ No ☐ Off
L_{up} = ft	Deceleration Lane Length L_D: 800	L_{down} = ft
V_u = veh/h	Freeway Volume, V_F: 3485	V_D = veh/h
	Ramp Volume, V_R: 819	
	Freeway Free-Flow Speed, S_{FF}: 65.0	
	Ramp Free-Flow Speed, S_{FR}: 45.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	3485	0.90	Level	9	0	0.957	1.00	4046
Ramp	819	0.90	Level	3	0	0.985	1.00	924
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 1.000 using Equation (Exhibit 13-7)

V_{12} = 4046 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	4046	Exhibit 13-8	4700	No
$V_{FO} = V_F - V_R$	3122	Exhibit 13-8	4700	No
V_R	924	Exhibit 13-10	2100	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	4046	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = 31.8 (pc/mi/ln)

LOS = D (Exhibit 13-2)

Speed Determination

D_s = 0.381 (Exhibit 13-12)

S_R= 56.2 mph (Exhibit 13-12)

S_0= N/A mph (Exhibit 13-12)

S = 56.2 mph (Exhibit 13-13)

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-526 EB*
Agency or Company	*Atkins*	From/To	*3235-RiverLa Off to RiverLa On*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2038 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*2416*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*12*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.943*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*65.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*65.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1423*	pc/h/ln
S	*65.0*	mph
D = v_p / S	*21.9*	pc/mi/ln
LOS	*C*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-526 EB*
Agency or Company	*Atkins*	From/To	*3235-RiverLa Off to RiverLa On*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*PM Peak*	Analysis Year	*2038 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*2666*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*12*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.943*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*65.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*65.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1570*	pc/h/ln
S	*64.6*	mph
D = v_p / S	*24.3*	pc/mi/ln
LOS	*C*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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F-3394

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-526 EB
Agency or Company	Atkins	Junction	3240-EB On from River Landing
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2038 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Freeway Number of Lanes, N: 2	☐ Yes ☐ On
☑ No ☐ Off	Ramp Number of Lanes, N: 1	☑ No ☐ Off
L_{up} = ft	Acceleration Lane Length, L_A: 1400	L_{down} = ft
V_u = veh/h	Deceleration Lane Length L_D:	V_D = veh/h
	Freeway Volume, V_F: 2416	
	Ramp Volume, V_R: 639	
	Freeway Free-Flow Speed, S_{FF}: 65.0	
	Ramp Free-Flow Speed, S_{FR}: 25.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	2416	0.90	Level	12	0	0.943	1.00	2846
Ramp	639	0.90	Level	8	0	0.962	1.00	738
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 1.000 using Equation (Exhibit 13-6)

V_{12} = 2846 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	3584	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	3584	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = 24.3 (pc/mi/ln)

LOS = C (Exhibit 13-2)

Speed Determination

M_S = 0.391 (Exibit 13-11)

S_R= 56.0 mph (Exhibit 13-11)

S_0= N/A mph (Exhibit 13-11)

S = 56.0 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-526 EB
Agency or Company	Atkins	Junction	3240-EB On from River Landing
Date Performed	4/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2038 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Freeway Number of Lanes, N: 2	☐ Yes ☐ On
☑ No ☐ Off	Ramp Number of Lanes, N: 1	☑ No ☐ Off
L_{up} = ft	Acceleration Lane Length, L_A: 1400	L_{down} = ft
V_u = veh/h	Deceleration Lane Length L_D:	V_D = veh/h
	Freeway Volume, V_F: 2666	
	Ramp Volume, V_R: 526	
	Freeway Free-Flow Speed, S_{FF}: 65.0	
	Ramp Free-Flow Speed, S_{FR}: 25.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	2666	0.90	Level	12	0	0.943	1.00	3140
Ramp	526	0.90	Level	10	0	0.952	1.00	614
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 1.000 using Equation (Exhibit 13-6)

V_{12} = 3140 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	3754	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	3754	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = 25.7 (pc/mi/ln)

LOS = C (Exhibit 13-2)

Speed Determination

M_S = 0.417 (Exibit 13-11)

S_R= 55.4 mph (Exhibit 13-11)

S_0= N/A mph (Exhibit 13-11)

S = 55.4 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-526 EB*
Agency or Company	*Atkins*	From/To	*3250-RiverLanding to LongPoint*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2038 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*3055*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*12*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.943*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*65.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*65.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1799*	pc/h/ln
S	*62.7*	mph
D = v_p / S	*28.7*	pc/mi/ln
LOS	*D*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-526 EB*
Agency or Company	*Atkins*	From/To	*3250-RiverLanding to LongPoint*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*PM Peak*	Analysis Year	*2038 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*3192*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*12*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.943*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*65.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*65.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1880*	pc/h/ln
S	*61.7*	mph
D = v_p / S	*30.5*	pc/mi/ln
LOS	*D*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-526 EB
Agency or Company	Atkins	Junction	3260-EB Off to Long Point
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2038 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Number of Lanes, N	2	Downstream Adj Ramp	
☐ Yes	☐ On	Acceleration Lane Length, L_A		☐ Yes	☐ On
☑ No	☐ Off	Deceleration Lane Length L_D	225	☑ No	☐ Off
L_{up} =	ft	Freeway Volume, V_F	3055	L_{down} =	ft
		Ramp Volume, V_R	1164		
V_u =	veh/h	Freeway Free-Flow Speed, S_{FF}	65.0	V_D =	veh/h
		Ramp Free-Flow Speed, S_{FR}	45.0		

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	3055	0.90	Level	12	0	0.943	1.00	3598
Ramp	1164	0.90	Level	23	0	0.897	1.00	1442
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 1.000 using Equation (Exhibit 13-7)

V_{12} = 3598 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	3598	Exhibit 13-8	4700	No
$V_{FO} = V_F - V_R$	2156	Exhibit 13-8	4700	No
V_R	1442	Exhibit 13-10	2100	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	3598	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = 33.2 (pc/mi/ln)

LOS = D (Exhibit 13-2)

Speed Determination

D_s = 0.428 (Exhibit 13-12)

S_R= 55.2 mph (Exhibit 13-12)

S_0= N/A mph (Exhibit 13-12)

S = 55.2 mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-526 EB
Agency or Company	Atkins	Junction	3260-EB Off to Long Point
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2038 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp
☐ Yes ☐ On
☑ No ☐ Off
L_{up} = ft
V_u = veh/h

Freeway Number of Lanes, N	2
Ramp Number of Lanes, N	1
Acceleration Lane Length, L_A	
Deceleration Lane Length L_D	225
Freeway Volume, V_F	3192
Ramp Volume, V_R	1248
Freeway Free-Flow Speed, S_{FF}	65.0
Ramp Free-Flow Speed, S_{FR}	45.0

Downstream Adj Ramp
☐ Yes ☐ On
☑ No ☐ Off
L_{down} = ft
V_D = veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	3192	0.90	Level	12	0	0.943	1.00	3759
Ramp	1248	0.90	Level	19	0	0.913	1.00	1518
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)
P_{FM} = using Equation (Exhibit 13-6)
V_{12} = pc/h
V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)
Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No
Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No
If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = (pc/mi/ln)
LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)
S_R= mph (Exhibit 13-11)
S_0= mph (Exhibit 13-11)
S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)
P_{FD} = 1.000 using Equation (Exhibit 13-7)
V_{12} = 3759 pc/h
V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)
Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No
Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No
If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	3759	Exhibit 13-8	4700	No
$V_{FO} = V_F - V_R$	2241	Exhibit 13-8	4700	No
V_R	1518	Exhibit 13-10	2100	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	3759	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = 34.6 (pc/mi/ln)
LOS = D (Exhibit 13-2)

Speed Determination

D_s = 0.435 (Exhibit 13-12)
S_R= 55.0 mph (Exhibit 13-12)
S_0= N/A mph (Exhibit 13-12)
S = 55.0 mph (Exhibit 13-13)

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-526 EB*
Agency or Company	*Atkins*	From/To	*3265-LongPt Off to LongPtWB On*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2038 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*1891*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*12*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.943*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*65.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*65.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1114*	pc/h/ln
S	*65.0*	mph
D = v_p / S	*17.1*	pc/mi/ln
LOS	*B*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-526 EB*
Agency or Company	*Atkins*	From/To	*3265-LongPt Off to LongPtWB On*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*PM Peak*	Analysis Year	*2038 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*1944*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*12*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.943*

Speed Inputs			Calc Speed Adj and FFS		
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f_{LW}		mph
Number of Lanes, N	*2*		f_{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	*65.0*	mph	FFS	*65.0*	mph
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures			Design (N)	
Operational (LOS)			Design (N)	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1145*	pc/h/ln	Design LOS	
S	*65.0*	mph	v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h/ln
D = v_p / S	*17.6*	pc/mi/ln	S	mph
LOS	*B*		D = v_p / S	pc/mi/ln
			Required Number of Lanes, N	

Glossary		Factor Location	
N - Number of lanes	S - Speed	E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
V - Hourly volume	D - Density	E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 11-18	TRD - Page 11-11
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 11-2, 11-3	
DDHV - Directional design hour volume			

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-526 EB
Agency or Company	Atkins	Junction	3270-EB On from Long Point WB
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2038 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Number of Lanes, N: 2	☐ Yes ☐ On
☑ No ☐ Off	Acceleration Lane Length, L_A: 925	☑ No ☐ Off
L_{up} = ft	Deceleration Lane Length L_D:	L_{down} = ft
V_u = veh/h	Freeway Volume, V_F: 1891	V_D = veh/h
	Ramp Volume, V_R: 531	
	Freeway Free-Flow Speed, S_{FF}: 65.0	
	Ramp Free-Flow Speed, S_{FR}: 25.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	1891	0.90	Level	12	0	0.943	1.00	2227
Ramp	531	0.90	Level	8	0	0.962	1.00	614
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 1.000 using Equation (Exhibit 13-6)

V_{12} = 2227 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	2841	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	2841	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = 21.6 (pc/mi/ln)

LOS = C (Exhibit 13-2)

Speed Determination

M_S = 0.342 (Exibit 13-11)

S_R= 57.1 mph (Exhibit 13-11)

S_0= N/A mph (Exhibit 13-11)

S = 57.1 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-526 EB
Agency or Company	Atkins	Junction	3270-EB On from Long Point WB
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2038 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp

☐ Yes ☐ On

☑ No ☐ Off

L_{up} = ft

V_u = veh/h

Freeway Number of Lanes, N	2
Ramp Number of Lanes, N	1
Acceleration Lane Length, L_A	925
Deceleration Lane Length L_D	
Freeway Volume, V_F	1944
Ramp Volume, V_R	531
Freeway Free-Flow Speed, S_{FF}	65.0
Ramp Free-Flow Speed, S_{FR}	25.0

Downstream Adj Ramp

☐ Yes ☐ On

☑ No ☐ Off

L_{down} = ft

V_D = veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	1944	0.90	Level	12	0	0.943	1.00	2290
Ramp	531	0.90	Level	7	0	0.966	1.00	611
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 1.000 using Equation (Exhibit 13-6)

V_{12} = 2290 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	2901	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	2901	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = 22.0 (pc/mi/ln)

LOS = C (Exhibit 13-2)

Speed Determination

M_S = 0.346 (Exibit 13-11)

S_R= 57.0 mph (Exhibit 13-11)

S_0= N/A mph (Exhibit 13-11)

S = 57.0 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-526 EB
Agency or Company	Atkins	Junction	3280-EB On from Long Point EB
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2038 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Number of Lanes, N: 2	☐ Yes ☐ On
☑ No ☐ Off	Acceleration Lane Length, L_A: 625	☑ No ☐ Off
L_{up} = ft	Deceleration Lane Length L_D:	L_{down} = ft
V_u = veh/h	Freeway Volume, V_F: 2422	V_D = veh/h
	Ramp Volume, V_R: 350	
	Freeway Free-Flow Speed, S_{FF}: 65.0	
	Ramp Free-Flow Speed, S_{FR}: 45.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	2422	0.90	Level	12	0	0.943	1.00	2853
Ramp	350	0.90	Level	18	0	0.917	1.00	424
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 1.000 using Equation (Exhibit 13-6)

V_{12} = 2853 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	3277	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	3277	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = 26.9 (pc/mi/ln)

LOS = C (Exhibit 13-2)

Speed Determination

M_S = 0.368 (Exibit 13-11)

S_R= 56.5 mph (Exhibit 13-11)

S_0= N/A mph (Exhibit 13-11)

S = 56.5 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-526 EB
Agency or Company	Atkins	Junction	3280-EB On from Long Point EB
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2038 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Freeway Number of Lanes, N: 2	☐ Yes ☐ On
☑ No ☐ Off	Ramp Number of Lanes, N: 1	☑ No ☐ Off
L_{up} = ft	Acceleration Lane Length, L_A: 625	L_{down} = ft
V_u = veh/h	Deceleration Lane Length L_D:	V_D = veh/h
	Freeway Volume, V_F: 2475	
	Ramp Volume, V_R: 678	
	Freeway Free-Flow Speed, S_{FF}: 65.0	
	Ramp Free-Flow Speed, S_{FR}: 45.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	2475	0.90	Level	12	0	0.943	1.00	2915
Ramp	678	0.90	Level	8	0	0.962	1.00	783
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 1.000 using Equation (Exhibit 13-6)

V_{12} = 2915 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	3698	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	3698	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = 30.0 (pc/mi/ln)

LOS = D (Exhibit 13-2)

Speed Determination

M_S = 0.422 (Exibit 13-11)

S_R= 55.3 mph (Exhibit 13-11)

S_0= N/A mph (Exhibit 13-11)

S = 55.3 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-526 EB*
Agency or Company	*Atkins*	From/To	*3290-LongPt.toUS17/Hungryneck*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2038 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*2772*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*10*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.952*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*65.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*65.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1617*	pc/h/ln
S	*64.3*	mph
D = v_p / S	*25.1*	pc/mi/ln
LOS	*C*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-526 EB*
Agency or Company	*Atkins*	From/To	*3290-LongPt.toUS17/Hungryneck*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*PM Peak*	Analysis Year	*2038 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*3153*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*8*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length	*mi*
			Up/Down %	

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.962*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*65.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*65.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1822*	pc/h/ln
S	*62.5*	mph
D = v_p / S	*29.2*	pc/mi/ln
LOS	*D*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-526 EB
Agency or Company	Atkins	Junction	3300-EB Off to US17/Hungryneck
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2038 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Number of Lanes, N	2	Downstream Adj Ramp	
☐ Yes	☐ On	Acceleration Lane Length, L_A		☐ Yes	☐ On
☑ No	☐ Off	Deceleration Lane Length L_D	225	☑ No	☐ Off
L_{up} =	ft	Freeway Volume, V_F	2772	L_{down} =	ft
V_u =	veh/h	Ramp Volume, V_R	1175	V_D =	veh/h
		Freeway Free-Flow Speed, S_{FF}	55.0		
		Ramp Free-Flow Speed, S_{FR}	45.0		

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	2772	0.90	Level	10	0	0.952	1.00	3234
Ramp	1175	0.90	Level	4	0	0.980	1.00	1332
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 1.000 using Equation (Exhibit 13-7)

V_{12} = 3234 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	3234	Exhibit 13-8	4500	No
$V_{FO} = V_F - V_R$	1902	Exhibit 13-8	4500	No
V_R	1332	Exhibit 13-10	2100	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	3234	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = 30.0 (pc/mi/ln)

LOS = D (Exhibit 13-2)

Speed Determination

D_s = 0.418 (Exhibit 13-12)

S_R= 49.6 mph (Exhibit 13-12)

S_0= N/A mph (Exhibit 13-12)

S = 49.6 mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-526 EB
Agency or Company	Atkins	Junction	3300-EB Off to US17/Hungryneck
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2038 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Number of Lanes, N	2	Downstream Adj Ramp	
☐ Yes	☐ On	Acceleration Lane Length, L_A		☐ Yes	☐ On
☑ No	☐ Off	Deceleration Lane Length L_D	225	☑ No	☐ Off
L_{up} =	ft	Freeway Volume, V_F	3153	L_{down} =	ft
		Ramp Volume, V_R	1006		
V_u =	veh/h	Freeway Free-Flow Speed, S_{FF}	55.0	V_D =	veh/h
		Ramp Free-Flow Speed, S_{FR}	45.0		

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	3153	0.90	Level	8	0	0.962	1.00	3643
Ramp	1006	0.90	Level	4	0	0.980	1.00	1140
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 1.000 using Equation (Exhibit 13-7)

V_{12} = 3643 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	3643	Exhibit 13-8	4500	No
$V_{FO} = V_F - V_R$	2503	Exhibit 13-8	4500	No
V_R	1140	Exhibit 13-10	2100	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	3643	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = 33.6 (pc/mi/ln)

LOS = D (Exhibit 13-2)

Speed Determination

D_s = 0.401 (Exhibit 13-12)

S_R= 49.8 mph (Exhibit 13-12)

S_0= N/A mph (Exhibit 13-12)

S = 49.8 mph (Exhibit 13-13)

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-526 EB*
Agency or Company	*Atkins*	From/To	*3310-US17/Hungryneck to US17*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2038 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*1597*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*8*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.962*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*55.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*55.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*923*	pc/h/ln
S	*55.0*	mph
D = v_p / S	*16.8*	pc/mi/ln
LOS	*B*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-526 EB*
Agency or Company	*Atkins*	From/To	*3310-US17/Hungryneck to US17*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*PM Peak*	Analysis Year	*2038 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*2147*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*6*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.971*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*55.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*55.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1229*	pc/h/ln
S	*55.0*	mph
D = v_p / S	*22.3*	pc/mi/ln
LOS	*C*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-526 EB
Agency or Company	Atkins	Junction	3320-EB Off to US17 SB
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2038 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Number of Lanes, N	2	Downstream Adj Ramp	
☐ Yes	☐ On	Acceleration Lane Length, L_A		☐ Yes	☐ On
☑ No	☐ Off	Deceleration Lane Length L_D	250	☑ No	☐ Off
L_{up} =	ft	Freeway Volume, V_F	1597	L_{down} =	ft
V_u =	veh/h	Ramp Volume, V_R	1139	V_D =	veh/h
		Freeway Free-Flow Speed, S_{FF}	55.0		
		Ramp Free-Flow Speed, S_{FR}	45.0		

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	1597	0.90	Level	8	0	0.962	1.00	1845
Ramp	1139	0.90	Level	12	0	0.943	1.00	1341
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 1.000 using Equation (Exhibit 13-7)

V_{12} = 1845 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	1845	Exhibit 13-8	4500	No
$V_{FO} = V_F - V_R$	504	Exhibit 13-8	4500	No
V_R	1341	Exhibit 13-10	2100	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	1845	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = 17.9 (pc/mi/ln)

LOS = B (Exhibit 13-2)

Speed Determination

D_s = 0.419 (Exhibit 13-12)

S_R= 49.6 mph (Exhibit 13-12)

S_0= N/A mph (Exhibit 13-12)

S = 49.6 mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-526 EB
Agency or Company	Atkins	Junction	3320-EB Off to US17 SB
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2038 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Number of Lanes, N: 2	☐ Yes ☐ On
☑ No ☐ Off	Acceleration Lane Length, L_A:	☑ No ☐ Off
L_{up} = ft	Deceleration Lane Length L_D: 250	L_{down} = ft
V_u = veh/h	Freeway Volume, V_F: 2147	V_D = veh/h
	Ramp Volume, V_R: 1116	
	Freeway Free-Flow Speed, S_{FF}: 55.0	
	Ramp Free-Flow Speed, S_{FR}: 45.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	2147	0.90	Level	6	0	0.971	1.00	2457
Ramp	1116	0.90	Level	11	0	0.948	1.00	1308
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 1.000 using Equation (Exhibit 13-7)

V_{12} = 2457 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	2457	Exhibit 13-8	4500	No
$V_{FO} = V_F - V_R$	1149	Exhibit 13-8	4500	No
V_R	1308	Exhibit 13-10	2100	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	2457	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = 23.1 (pc/mi/ln)

LOS = C (Exhibit 13-2)

Speed Determination

D_s = 0.416 (Exhibit 13-12)

S_R= 49.6 mph (Exhibit 13-12)

S_0= N/A mph (Exhibit 13-12)

S = 49.6 mph (Exhibit 13-13)

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-526 EB*
Agency or Company	*Atkins*	From/To	*3325-US17 SB Off to US17 SB On*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2038 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*458*	veh/h	Peak-Hour Factor, PHF	*0.90*	
AADT		veh/day	%Trucks and Buses, P_T	*8*	
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*	
Peak-Hr Direction Prop, D			General Terrain:	*Level*	
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*	

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.962*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*55.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*55.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*265*	pc/h/ln
S	*55.0*	mph
D = v_p / S	*4.8*	pc/mi/ln
LOS	*A*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-526 EB*
Agency or Company	*Atkins*	From/To	*3325-US17 SB Off to US17 SB On*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*PM Peak*	Analysis Year	*2038 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*1031*	veh/h	Peak-Hour Factor, PHF	*0.90*	
AADT		veh/day	%Trucks and Buses, P_T	*6*	
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*	
Peak-Hr Direction Prop, D			General Terrain:	*Level*	
DDHV = AADT x K x D		veh/h	Grade % Length	*mi*	
			Up/Down %		

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.971*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*55.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*55.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*590*	pc/h/ln
S	*55.0*	mph
D = v_p / S	*10.7*	pc/mi/ln
LOS	*A*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-526 EB
Agency or Company	Atkins	Junction	3330-EB On from US17 SB
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2038 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Number of Lanes, N: 2	☐ Yes ☐ On
☑ No ☐ Off	Acceleration Lane Length, L_A: 725	☑ No ☐ Off
L_{up} = ft	Deceleration Lane Length L_D:	L_{down} = ft
V_u = veh/h	Freeway Volume, V_F: 458	V_D = veh/h
	Ramp Volume, V_R: 378	
	Freeway Free-Flow Speed, S_{FF}: 55.0	
	Ramp Free-Flow Speed, S_{FR}: 25.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	458	0.90	Level	8	0	0.962	1.00	529
Ramp	378	0.90	Level	3	0	0.985	1.00	426
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 1.000 using Equation (Exhibit 13-6)

V_{12} = 529 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	955	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	955	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = 8.2 (pc/mi/ln)

LOS = A (Exhibit 13-2)

Speed Determination

M_S = 0.295 (Exibit 13-11)

S_R= 51.2 mph (Exhibit 13-11)

S_0= N/A mph (Exhibit 13-11)

S = 51.2 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-526 EB
Agency or Company	Atkins	Junction	3330-EB On from US17 SB
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2038 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Number of Lanes, N: 2	☐ Yes ☐ On
☑ No ☐ Off	Acceleration Lane Length, L_A: 725	☑ No ☐ Off
L_{up} = ft	Deceleration Lane Length L_D:	L_{down} = ft
V_u = veh/h	Freeway Volume, V_F: 1031	V_D = veh/h
	Ramp Volume, V_R: 305	
	Freeway Free-Flow Speed, S_{FF}: 55.0	
	Ramp Free-Flow Speed, S_{FR}: 25.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	1031	0.90	Level	6	0	0.971	1.00	1180
Ramp	305	0.90	Level	4	0	0.980	1.00	346
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 1.000 using Equation (Exhibit 13-6)

V_{12} = 1180 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	1526	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	1526	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = 12.7 (pc/mi/ln)

LOS = B (Exhibit 13-2)

Speed Determination

M_S = 0.303 (Exibit 13-11)

S_R= 51.1 mph (Exhibit 13-11)

S_0= N/A mph (Exhibit 13-11)

S = 51.1 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-526 EB
Agency or Company	Atkins	Junction	3340-EB On from US17 NB
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2038 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Number of Lanes, N: 2	☐ Yes ☐ On
☑ No ☐ Off	Acceleration Lane Length, L_A: 550	☑ No ☐ Off
L_{up} = ft	Deceleration Lane Length L_D:	L_{down} = ft
V_u = veh/h	Freeway Volume, V_F: 836	V_D = veh/h
	Ramp Volume, V_R: 24	
	Freeway Free-Flow Speed, S_{FF}: 55.0	
	Ramp Free-Flow Speed, S_{FR}: 45.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	836	0.90	Level	8	0	0.962	1.00	966
Ramp	24	0.90	Level	4	0	0.980	1.00	27
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 1.000 using Equation (Exhibit 13-6)

V_{12} = 966 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	993	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	993	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = 9.8 (pc/mi/ln)

LOS = A (Exhibit 13-2)

Speed Determination

M_S = 0.282 (Exibit 13-11)

S_R= 51.3 mph (Exhibit 13-11)

S_0= N/A mph (Exhibit 13-11)

S = 51.3 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-526 EB
Agency or Company	Atkins	Junction	3340-EB On from US17 NB
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2038 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Number of Lanes, N: 2	☐ Yes ☐ On
☑ No ☐ Off	Acceleration Lane Length, L_A: 550	☑ No ☐ Off
L_{up} = ft	Deceleration Lane Length L_D:	L_{down} = ft
V_u = veh/h	Freeway Volume, V_F: 1336	V_D = veh/h
	Ramp Volume, V_R: 32	
	Freeway Free-Flow Speed, S_{FF}: 55.0	
	Ramp Free-Flow Speed, S_{FR}: 45.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	1336	0.90	Level	6	0	0.971	1.00	1529
Ramp	32	0.90	Level	3	0	0.985	1.00	36
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 1.000 using Equation (Exhibit 13-6)

V_{12} = 1529 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	1565	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	1565	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = 14.2 (pc/mi/ln)

LOS = B (Exhibit 13-2)

Speed Determination

M_S = 0.290 (Exibit 13-11)

S_R= 51.2 mph (Exhibit 13-11)

S_0= N/A mph (Exhibit 13-11)

S = 51.2 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-526 WB
Agency or Company	Atkins	Junction	4010-WB Off to US17 NB
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2038 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Number of Lanes, N	2	Downstream Adj Ramp	
☐ Yes	☐ On	Acceleration Lane Length, L_A		☐ Yes	☐ On
☑ No	☐ Off	Deceleration Lane Length L_D	300	☑ No	☐ Off
L_{up} =	ft	Freeway Volume, V_F	1087	L_{down} =	ft
V_u =	veh/h	Ramp Volume, V_R	333	V_D =	veh/h
		Freeway Free-Flow Speed, S_{FF}	55.0		
		Ramp Free-Flow Speed, S_{FR}	45.0		

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	1087	0.90	Level	8	0	0.962	1.00	1256
Ramp	333	0.90	Level	12	0	0.943	1.00	392
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 1.000 using Equation (Exhibit 13-7)

V_{12} = 1256 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	1256	Exhibit 13-8	4500	No
$V_{FO} = V_F - V_R$	864	Exhibit 13-8	4500	No
V_R	392	Exhibit 13-10	2100	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	1256	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = 12.4 (pc/mi/ln)

LOS = B (Exhibit 13-2)

Speed Determination

D_s = 0.333 (Exhibit 13-12)

S_R= 50.7 mph (Exhibit 13-12)

S_0= N/A mph (Exhibit 13-12)

S = 50.7 mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-526 WB
Agency or Company	Atkins	Junction	4010-WB Off to US17 NB
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2038 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Number of Lanes, N	2	Downstream Adj Ramp	
☐ Yes	☐ On	Acceleration Lane Length, L_A		☐ Yes	☐ On
☑ No	☐ Off	Deceleration Lane Length L_D	300	☑ No	☐ Off
L_{up} =	ft	Freeway Volume, V_F	1208	L_{down} =	ft
V_u =	veh/h	Ramp Volume, V_R	477	V_D =	veh/h
		Freeway Free-Flow Speed, S_{FF}	55.0		
		Ramp Free-Flow Speed, S_{FR}	45.0		

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	1208	0.90	Level	6	0	0.971	1.00	1382
Ramp	477	0.90	Level	7	0	0.966	1.00	549
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 1.000 using Equation (Exhibit 13-7)

V_{12} = 1382 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	1382	Exhibit 13-8	4500	No
$V_{FO} = V_F - V_R$	833	Exhibit 13-8	4500	No
V_R	549	Exhibit 13-10	2100	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	1382	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = 13.4 (pc/mi/ln)

LOS = B (Exhibit 13-2)

Speed Determination

D_s = 0.347 (Exhibit 13-12)

S_R= 50.5 mph (Exhibit 13-12)

S_0= N/A mph (Exhibit 13-12)

S = 50.5 mph (Exhibit 13-13)

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-526 WB*
Agency or Company	*Atkins*	From/To	*4015-US17 NB off to US17 NB On*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2038 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*754*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*8*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.962*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*55.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*55.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*436*	pc/h/ln
S	*55.0*	mph
D = v_p / S	*7.9*	pc/mi/ln
LOS	*A*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-526 WB*
Agency or Company	*Atkins*	From/To	*4015-US17 NB off to US17 NB On*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*PM Peak*	Analysis Year	*2038 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*731*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*6*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.971*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*55.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*55.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*418*	pc/h/ln
S	*55.0*	mph
D = v_p / S	*7.6*	pc/mi/ln
LOS	*A*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-526 WB
Agency or Company	Atkins	Junction	4020-WB On from US17 NB
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2038 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Freeway Number of Lanes, N: 2	☐ Yes ☐ On
☑ No ☐ Off	Ramp Number of Lanes, N: 1	☑ No ☐ Off
L_{up} = ft	Acceleration Lane Length, L_A: 775	L_{down} = ft
V_u = veh/h	Deceleration Lane Length L_D:	V_D = veh/h
	Freeway Volume, V_F: 754	
	Ramp Volume, V_R: 968	
	Freeway Free-Flow Speed, S_{FF}: 55.0	
	Ramp Free-Flow Speed, S_{FR}: 25.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	754	0.90	Level	8	0	0.962	1.00	871
Ramp	968	0.90	Level	8	0	0.962	1.00	1119
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 1.000 using Equation (Exhibit 13-6)

V_{12} = 871 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	1990	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	1990	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = 15.6 (pc/mi/ln)

LOS = B (Exhibit 13-2)

Speed Determination

M_S = 0.311 (Exibit 13-11)

S_R= 51.0 mph (Exhibit 13-11)

S_0= N/A mph (Exhibit 13-11)

S = 51.0 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-526 WB
Agency or Company	Atkins	Junction	4020-WB On from US17 NB
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2038 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Freeway Number of Lanes, N: 2	☐ Yes ☐ On
☑ No ☐ Off	Ramp Number of Lanes, N: 1	☑ No ☐ Off
L_{up} = ft	Acceleration Lane Length, L_A: 775	L_{down} = ft
V_u = veh/h	Deceleration Lane Length L_D:	V_D = veh/h
	Freeway Volume, V_F: 731	
	Ramp Volume, V_R: 946	
	Freeway Free-Flow Speed, S_{FF}: 55.0	
	Ramp Free-Flow Speed, S_{FR}: 25.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	731	0.90	Level	6	0	0.971	1.00	837
Ramp	946	0.90	Level	7	0	0.966	1.00	1088
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 1.000 using Equation (Exhibit 13-6)

V_{12} = 837 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	1925	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	1925	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = 15.1 (pc/mi/ln)

LOS = B (Exhibit 13-2)

Speed Determination

M_S = 0.309 (Exibit 13-11)

S_R= 51.0 mph (Exhibit 13-11)

S_0= N/A mph (Exhibit 13-11)

S = 51.0 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-526 WB*
Agency or Company	*Atkins*	From/To	*4030-US17 to US17/Hungryneck*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2038 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*1722*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*8*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.962*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*55.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*55.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*995*	pc/h/ln
S	*55.0*	mph
D = v_p / S	*18.1*	pc/mi/ln
LOS	*C*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-526 WB*
Agency or Company	*Atkins*	From/To	*4030-US17 to US17/Hungryneck*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*PM Peak*	Analysis Year	*2038 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*1677*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*6*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.971*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*55.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*55.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*960*	pc/h/ln
S	*55.0*	mph
D = v_p / S	*17.5*	pc/mi/ln
LOS	*B*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-526 WB
Agency or Company	Atkins	Junction	4020-WB On from US17/Hungrynec
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2038 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Number of Lanes, N: 2	☐ Yes ☐ On
☑ No ☐ Off	Acceleration Lane Length, L_A: 425	☑ No ☐ Off
L_{up} = ft	Deceleration Lane Length L_D:	L_{down} = ft
V_u = veh/h	Freeway Volume, V_F: 1722	V_D = veh/h
	Ramp Volume, V_R: 917	
	Freeway Free-Flow Speed, S_{FF}: 55.0	
	Ramp Free-Flow Speed, S_{FR}: 45.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	1722	0.90	Level	8	0	0.962	1.00	1990
Ramp	917	0.90	Level	25	0	0.889	1.00	1146
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 1.000 using Equation (Exhibit 13-6)

V_{12} = 1990 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * $V_{12}/2$ ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	3136	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	3136	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = 26.7 (pc/mi/ln)

LOS = C (Exhibit 13-2)

Speed Determination

M_S = 0.372 (Exibit 13-11)

S_R= 50.2 mph (Exhibit 13-11)

S_0= N/A mph (Exhibit 13-11)

S = 50.2 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * $V_{12}/2$ ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-526 WB
Agency or Company	Atkins	Junction	4020-WB On from US17/Hungrynec
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2038 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Number of Lanes, N: 2	☐ Yes ☐ On
☑ No ☐ Off	Acceleration Lane Length, L_A: 425	☑ No ☐ Off
L_{up} = ft	Deceleration Lane Length L_D:	L_{down} = ft
V_u = veh/h	Freeway Volume, V_F: 1677	V_D = veh/h
	Ramp Volume, V_R: 1325	
	Freeway Free-Flow Speed, S_{FF}: 55.0	
	Ramp Free-Flow Speed, S_{FR}: 45.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	1677	0.90	Level	6	0	0.971	1.00	1919
Ramp	1325	0.90	Level	15	0	0.930	1.00	1583
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 1.000 using Equation (Exhibit 13-6)

V_{12} = 1919 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * $V_{12}/2$ ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	3502	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	3502	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = 29.4 (pc/mi/ln)

LOS = D (Exhibit 13-2)

Speed Determination

M_S = 0.412 (Exibit 13-11)

S_R= 49.6 mph (Exhibit 13-11)

S_0= N/A mph (Exhibit 13-11)

S = 49.6 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * $V_{12}/2$ ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-526 WB*
Agency or Company	*Atkins*	From/To	*4050-US17/Hungryneck to LongPt*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2038 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*2639*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*10*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.952*

Speed Inputs			Calc Speed Adj and FFS		
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f_{LW}		mph
Number of Lanes, N	*2*		f_{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	*65.0*	mph	FFS	*65.0*	mph
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures			Design (N)	
Operational (LOS)			Design (N)	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1539*	pc/h/ln	Design LOS	
S	*64.7*	mph	v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h/ln
D = v_p / S	*23.8*	pc/mi/ln	S	mph
LOS	*C*		D = v_p / S	pc/mi/ln
			Required Number of Lanes, N	

Glossary		Factor Location	
N - Number of lanes	S - Speed	E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
V - Hourly volume	D - Density	E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 11-18	TRD - Page 11-11
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 11-2, 11-3	
DDHV - Directional design hour volume			

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-526 WB*
Agency or Company	*Atkins*	From/To	*4050-US17/Hungryneck to LongPt*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*PM Peak*	Analysis Year	*2038 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*3002*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*8*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.962*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*65.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*65.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1734*	pc/h/ln
S	*63.4*	mph
D = v_p / S	*27.3*	pc/mi/ln
LOS	*D*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-526 WB
Agency or Company	Atkins	Junction	4060-WB Off to Long Point
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2038 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Number of Lanes, N	2	Downstream Adj Ramp	
☐ Yes	☐ On	Acceleration Lane Length, L_A		☐ Yes	☐ On
☑ No	☐ Off	Deceleration Lane Length L_D	250	☑ No	☐ Off
L_{up} =	ft	Freeway Volume, V_F	2639	L_{down} =	ft
		Ramp Volume, V_R	595		
V_u =	veh/h	Freeway Free-Flow Speed, S_{FF}	65.0	V_D =	veh/h
		Ramp Free-Flow Speed, S_{FR}	45.0		

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	2639	0.90	Level	10	0	0.952	1.00	3079
Ramp	595	0.90	Level	21	0	0.905	1.00	731
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 1.000 using Equation (Exhibit 13-7)

V_{12} = 3079 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	3079	Exhibit 13-8	4700	No
$V_{FO} = V_F - V_R$	2348	Exhibit 13-8	4700	No
V_R	731	Exhibit 13-10	2100	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	3079	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = 28.5 (pc/mi/ln)

LOS = D (Exhibit 13-2)

Speed Determination

D_s = 0.364 (Exhibit 13-12)

S_R= 56.6 mph (Exhibit 13-12)

S_0= N/A mph (Exhibit 13-12)

S = 56.6 mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-526 WB
Agency or Company	Atkins	Junction	4060-WB Off to Long Point
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2038 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Number of Lanes, N	2	Downstream Adj Ramp	
☐ Yes	☐ On	Acceleration Lane Length, L_A		☐ Yes	☐ On
☑ No	☐ Off	Deceleration Lane Length L_D	250	☑ No	☐ Off
L_{up} =	ft	Freeway Volume, V_F	3002	L_{down} =	ft
		Ramp Volume, V_R	1357		
V_u =	veh/h	Freeway Free-Flow Speed, S_{FF}	65.0	V_D =	veh/h
		Ramp Free-Flow Speed, S_{FR}	45.0		

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	3002	0.90	Level	8	0	0.962	1.00	3469
Ramp	1357	0.90	Level	8	0	0.962	1.00	1568
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 1.000 using Equation (Exhibit 13-7)

V_{12} = 3469 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	3469	Exhibit 13-8	4700	No
$V_{FO} = V_F - V_R$	1901	Exhibit 13-8	4700	No
V_R	1568	Exhibit 13-10	2100	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	3469	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = 31.8 (pc/mi/ln)

LOS = D (Exhibit 13-2)

Speed Determination

D_s = 0.439 (Exhibit 13-12)

S_R= 54.9 mph (Exhibit 13-12)

S_0= N/A mph (Exhibit 13-12)

S = 54.9 mph (Exhibit 13-13)

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-526 WB*
Agency or Company	*Atkins*	From/To	*4065-LongPt Off to LongPtEB On*
Date Performed	*4/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2038 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*2044*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*12*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.943*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*65.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*65.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1204*	pc/h/ln
S	*65.0*	mph
D = v_p / S	*18.5*	pc/mi/ln
LOS	*C*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-526 WB*
Agency or Company	*Atkins*	From/To	*4065-LongPt Off to LongPtEB On*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*PM Peak*	Analysis Year	*2038 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*1645*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*12*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.943*

Speed Inputs			Calc Speed Adj and FFS		
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f_{LW}		mph
Number of Lanes, N	*2*		f_{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	*65.0*	mph	FFS	*65.0*	mph
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures			Design (N)	
Operational (LOS)			Design (N)	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*969*	pc/h/ln	Design LOS	
			v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h/ln
S	*65.0*	mph	S	mph
D = v_p / S	*14.9*	pc/mi/ln	D = v_p / S	pc/mi/ln
LOS	*B*		Required Number of Lanes, N	

Glossary		Factor Location	
N - Number of lanes	S - Speed	E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
V - Hourly volume	D - Density	E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 11-18	TRD - Page 11-11
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 11-2, 11-3	
DDHV - Directional design hour volume			

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-526 WB
Agency or Company	Atkins	Junction	4070-WB On from Long Point EB
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2038 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Number of Lanes, N: 2	☐ Yes ☐ On
☑ No ☐ Off	Acceleration Lane Length, L_A: 950	☑ No ☐ Off
L_{up} = ft	Deceleration Lane Length L_D:	L_{down} = ft
V_u = veh/h	Freeway Volume, V_F: 2044	V_D = veh/h
	Ramp Volume, V_R: 618	
	Freeway Free-Flow Speed, S_{FF}: 65.0	
	Ramp Free-Flow Speed, S_{FR}: 25.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	2044	0.90	Level	12	0	0.943	1.00	2407
Ramp	618	0.90	Level	21	0	0.905	1.00	759
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 1.000 using Equation (Exhibit 13-6)

V_{12} = 2407 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	3166	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	3166	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = 23.9 (pc/mi/ln)

LOS = C (Exhibit 13-2)

Speed Determination

M_S = 0.366 (Exibit 13-11)

S_R= 56.6 mph (Exhibit 13-11)

S_0= N/A mph (Exhibit 13-11)

S = 56.6 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-526 WB
Agency or Company	Atkins	Junction	4070-WB On from Long Point EB
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2038 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Freeway Number of Lanes, N: 2	☐ Yes ☐ On
☑ No ☐ Off	Ramp Number of Lanes, N: 1	☑ No ☐ Off
L_{up} = ft	Acceleration Lane Length, L_A: 950	L_{down} = ft
V_u = veh/h	Deceleration Lane Length L_D:	V_D = veh/h
	Freeway Volume, V_F: 1645	
	Ramp Volume, V_R: 686	
	Freeway Free-Flow Speed, S_{FF}: 65.0	
	Ramp Free-Flow Speed, S_{FR}: 25.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	1645	0.90	Level	12	0	0.943	1.00	1937
Ramp	686	0.90	Level	16	0	0.926	1.00	823
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 1.000 using Equation (Exhibit 13-6)

V_{12} = 1937 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	2760	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	2760	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = 20.7 (pc/mi/ln)

LOS = C (Exhibit 13-2)

Speed Determination

M_S = 0.335 (Exibit 13-11)

S_R= 57.3 mph (Exhibit 13-11)

S_0= N/A mph (Exhibit 13-11)

S = 57.3 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	2662	Freeway/Dir of Travel	I-526 WB
Agency or Company	Atkins	Junction	4080-WB On from Long Point WB
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2038 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Number of Lanes, N: 2	☐ Yes ☐ On
☑ No ☐ Off	Acceleration Lane Length, L_A: 1025	☑ No ☐ Off
L_{up} = ft	Deceleration Lane Length L_D:	L_{down} = ft
V_u = veh/h	Freeway Volume, V_F: 2662	V_D = veh/h
	Ramp Volume, V_R: 1458	
	Freeway Free-Flow Speed, S_{FF}: 65.0	
	Ramp Free-Flow Speed, S_{FR}: 45.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	2662	0.90	Level	12	0	0.943	1.00	3135
Ramp	1458	0.90	Level	7	0	0.966	1.00	1677
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 1.000 using Equation (Exhibit 13-6)

V_{12} = 3135 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	4812	Exhibit 13-8		Yes

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	4812	Exhibit 13-8	4600:All	Yes

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = 35.8 (pc/mi/ln)

LOS = F (Exhibit 13-2)

Speed Determination

M_S = 0.708 (Exibit 13-11)

S_R= 48.7 mph (Exhibit 13-11)

S_0= N/A mph (Exhibit 13-11)

S = 48.7 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-526 WB
Agency or Company	Atkins	Junction	4080-WB On from Long Point WB
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2038 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Freeway Number of Lanes, N: 2	☐ Yes ☐ On
☑ No ☐ Off	Ramp Number of Lanes, N: 1	☑ No ☐ Off
L_{up} = ft	Acceleration Lane Length, L_A: 1025	L_{down} = ft
V_u = veh/h	Deceleration Lane Length L_D:	V_D = veh/h
	Freeway Volume, V_F: 2331	
	Ramp Volume, V_R: 1058	
	Freeway Free-Flow Speed, S_{FF}: 65.0	
	Ramp Free-Flow Speed, S_{FR}: 45.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	2331	0.90	Level	12	0	0.943	1.00	2745
Ramp	1058	0.90	Level	9	0	0.957	1.00	1228
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 1.000 using Equation (Exhibit 13-6)

V_{12} = 2745 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	3973	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	3973	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = 29.5 (pc/mi/ln)

LOS = D (Exhibit 13-2)

Speed Determination

M_S = 0.436 (Exibit 13-11)

S_R= 55.0 mph (Exhibit 13-11)

S_0= N/A mph (Exhibit 13-11)

S = 55.0 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-526 WB*
Agency or Company	*Atkins*	From/To	*4090-Long Point to Island Park*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2038 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*4120*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*12*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.943*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*65.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*65.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*2426*	pc/h/ln
S	*50.1*	mph
D = v_p / S	*48.4*	pc/mi/ln
LOS	*F*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-526 WB*
Agency or Company	*Atkins*	From/To	*4090-Long Point to Island Park*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*PM Peak*	Analysis Year	*2038 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*3389*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*12*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.943*

Speed Inputs			Calc Speed Adj and FFS		
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f_{LW}		mph
Number of Lanes, N	*2*		f_{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	*65.0*	mph	FFS	*65.0*	mph
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures			Design (N)	
Operational (LOS)			Design (N)	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1996*	pc/h/ln	Design LOS	
			v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h/ln
S	*60.0*	mph	S	mph
D = v_p / S	*33.3*	pc/mi/ln	D = v_p / S	pc/mi/ln
LOS	*D*		Required Number of Lanes, N	

Glossary		Factor Location	
N - Number of lanes	S - Speed	E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
V - Hourly volume	D - Density	E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 11-18	TRD - Page 11-11
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 11-2, 11-3	
DDHV - Directional design hour volume			

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-526 WB
Agency or Company	Atkins	Junction	4100-WB Off to Island Park
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2038 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Number of Lanes, N	2	Downstream Adj Ramp	
☐ Yes	☐ On	Acceleration Lane Length, L_A		☐ Yes	☐ On
☑ No	☐ Off	Deceleration Lane Length L_D	775	☑ No	☐ Off
L_{up} =	ft	Freeway Volume, V_F	4120	L_{down} =	ft
V_u =	veh/h	Ramp Volume, V_R	1121	V_D =	veh/h
		Freeway Free-Flow Speed, S_{FF}	65.0		
		Ramp Free-Flow Speed, S_{FR}	25.0		

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	4120	0.90	Level	12	0	0.943	1.00	4852
Ramp	1121	0.90	Level	10	0	0.952	1.00	1308
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 1.000 using Equation (Exhibit 13-7)

V_{12} = 4852 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	4852	Exhibit 13-8	4700	Yes
$V_{FO} = V_F - V_R$	3544	Exhibit 13-8	4700	No
V_R	1308	Exhibit 13-10	1900	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	4852	Exhibit 13-8	4400:All	Yes

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = 39.0 (pc/mi/ln)

LOS = F (Exhibit 13-2)

Speed Determination

D_s = 0.676 (Exhibit 13-12)

S_R= 49.5 mph (Exhibit 13-12)

S_0= N/A mph (Exhibit 13-12)

S = 49.5 mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-526 WB
Agency or Company	Atkins	Junction	4100-WB Off to Island Park
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2038 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Freeway Number of Lanes, N: 2	☐ Yes ☐ On
☑ No ☐ Off	Ramp Number of Lanes, N: 1	☑ No ☐ Off
L_{up} = ft	Acceleration Lane Length, L_A	L_{down} = ft
V_u = veh/h	Deceleration Lane Length L_D: 775	V_D = veh/h
	Freeway Volume, V_F: 3389	
	Ramp Volume, V_R: 607	
	Freeway Free-Flow Speed, S_{FF}: 65.0	
	Ramp Free-Flow Speed, S_{FR}: 25.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	3389	0.90	Level	12	0	0.943	1.00	3991
Ramp	607	0.90	Level	16	0	0.926	1.00	728
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 1.000 using Equation (Exhibit 13-7)

V_{12} = 3991 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	3991	Exhibit 13-8	4700	No
$V_{FO} = V_F - V_R$	3263	Exhibit 13-8	4700	No
V_R	728	Exhibit 13-10	1900	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	3991	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = 31.6 (pc/mi/ln)

LOS = D (Exhibit 13-2)

Speed Determination

D_s = 0.624 (Exhibit 13-12)

S_R= 50.7 mph (Exhibit 13-12)

S_0= N/A mph (Exhibit 13-12)

S = 50.7 mph (Exhibit 13-13)

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-526 WB*
Agency or Company	*Atkins*	From/To	*4105 - Is. Pk Off to Is. Pk On*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2038 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*2999*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*12*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.943*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*65.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*65.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1766*	pc/h/ln
S	*63.1*	mph
D = v_p / S	*28.0*	pc/mi/ln
LOS	*D*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-526 WB*
Agency or Company	*Atkins*	From/To	*4105 - Is. Pk Off to Is. Pk On*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*PM Peak*	Analysis Year	*2038 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*2782*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*12*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.943*

Speed Inputs			Calc Speed Adj and FFS		
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f_{LW}		mph
Number of Lanes, N	*2*		f_{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	*65.0*	mph	FFS	*65.0*	mph
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures			Design (N)	
Operational (LOS)			Design (N)	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1638*	pc/h/ln	Design LOS	
			v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h/ln
S	*64.2*	mph	S	mph
D = v_p / S	*25.5*	pc/mi/ln	D = v_p / S	pc/mi/ln
LOS	*C*		Required Number of Lanes, N	

Glossary		Factor Location	
N - Number of lanes	S - Speed	E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
V - Hourly volume	D - Density	E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 11-18	TRD - Page 11-11
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 11-2, 11-3	
DDHV - Directional design hour volume			

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-526 WB
Agency or Company	Atkins	Junction	4110-WB On from Island Park Dr
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2038 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Number of Lanes, N: 2	☐ Yes ☐ On
☑ No ☐ Off	Acceleration Lane Length, L_A: 1400	☑ No ☐ Off
L_{up} = ft	Deceleration Lane Length L_D:	L_{down} = ft
V_u = veh/h	Freeway Volume, V_F: 2999	V_D = veh/h
	Ramp Volume, V_R: 607	
	Freeway Free-Flow Speed, S_{FF}: 65.0	
	Ramp Free-Flow Speed, S_{FR}: 45.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	2999	0.90	Level	12	0	0.943	1.00	3532
Ramp	607	0.90	Level	7	0	0.966	1.00	698
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 1.000 using Equation (Exhibit 13-6)

V_{12} = 3532 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	4230	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	4230	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = 29.4 (pc/mi/ln)

LOS = D (Exhibit 13-2)

Speed Determination

M_S = 0.463 (Exibit 13-11)

S_R= 54.4 mph (Exhibit 13-11)

S_0= N/A mph (Exhibit 13-11)

S = 54.4 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-526 WB
Agency or Company	Atkins	Junction	4110-WB On from Island Park Dr
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2038 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Freeway Number of Lanes, N: 2	☐ Yes ☐ On
☑ No ☐ Off	Ramp Number of Lanes, N: 1	☑ No ☐ Off
L_{up} = ft	Acceleration Lane Length, L_A: 1400	L_{down} = ft
V_u = veh/h	Deceleration Lane Length L_D:	V_D = veh/h
	Freeway Volume, V_F: 2782	
	Ramp Volume, V_R: 704	
	Freeway Free-Flow Speed, S_{FF}: 65.0	
	Ramp Free-Flow Speed, S_{FR}: 45.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	2782	0.90	Level	12	0	0.943	1.00	3277
Ramp	704	0.90	Level	5	0	0.976	1.00	802
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 1.000 using Equation (Exhibit 13-6)

V_{12} = 3277 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	4079	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	4079	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = 28.1 (pc/mi/ln)

LOS = D (Exhibit 13-2)

Speed Determination

M_S = 0.425 (Exibit 13-11)

S_R= 55.2 mph (Exhibit 13-11)

S_0= N/A mph (Exhibit 13-11)

S = 55.2 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-526 WB*
Agency or Company	*Atkins*	From/To	*4120-IslandParktoClementsFerry*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2038 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*3606*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*11*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.948*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*65.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*65.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*2114*	pc/h/ln
S	*57.8*	mph
D = v_p / S	*36.6*	pc/mi/ln
LOS	*E*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-526 WB*
Agency or Company	*Atkins*	From/To	*4120-IslandParktoClementsFerry*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*PM Peak*	Analysis Year	*2038 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs				
Volume, V	*3486*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*9*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length	*mi*
			Up/Down %	

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.957*

Speed Inputs			Calc Speed Adj and FFS		
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f_{LW}		mph
Number of Lanes, N	*2*		f_{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	*65.0*	mph	FFS	*65.0*	mph
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures			Design (N)	
Operational (LOS)			Design (N)	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*2024*	pc/h/ln	Design LOS	
			v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h/ln
S	*59.5*	mph	S	mph
D = v_p / S	*34.0*	pc/mi/ln	D = v_p / S	pc/mi/ln
LOS	*D*		Required Number of Lanes, N	

Glossary		Factor Location	
N - Number of lanes	S - Speed	E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
V - Hourly volume	D - Density	E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 11-18	TRD - Page 11-11
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 11-2, 11-3	
DDHV - Directional design hour volume			

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-526 WB
Agency or Company	Atkins	Junction	4130-WB Off to Clements Ferry
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2038 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Number of Lanes, N: 2	☐ Yes ☐ On
☑ No ☐ Off	Acceleration Lane Length, L_A:	☑ No ☐ Off
L_{up} = ft	Deceleration Lane Length L_D: 240	L_{down} = ft
V_u = veh/h	Freeway Volume, V_F: 3606	V_D = veh/h
	Ramp Volume, V_R: 548	
	Freeway Free-Flow Speed, S_{FF}: 60.0	
	Ramp Free-Flow Speed, S_{FR}: 45.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	3606	0.90	Level	11	0	0.948	1.00	4227
Ramp	548	0.90	Level	17	0	0.922	1.00	661
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 1.000 using Equation (Exhibit 13-7)

V_{12} = 4227 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	4227	Exhibit 13-8	4600	No
$V_{FO} = V_F - V_R$	3566	Exhibit 13-8	4600	No
V_R	661	Exhibit 13-10	2100	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	4227	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = 38.4 (pc/mi/ln)

LOS = E (Exhibit 13-2)

Speed Determination

D_s = 0.357 (Exhibit 13-12)

S_R= 53.6 mph (Exhibit 13-12)

S_0= N/A mph (Exhibit 13-12)

S = 53.6 mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-526 WB
Agency or Company	Atkins	Junction	4130-WB Off to Clements Ferry
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2038 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Number of Lanes, N: 2	☐ Yes ☐ On
☑ No ☐ Off	Acceleration Lane Length, L_A	☑ No ☐ Off
L_{up} = ft	Deceleration Lane Length L_D: 240	L_{down} = ft
V_u = veh/h	Freeway Volume, V_F: 3486	V_D = veh/h
	Ramp Volume, V_R: 454	
	Freeway Free-Flow Speed, S_{FF}: 60.0	
	Ramp Free-Flow Speed, S_{FR}: 45.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	3486	0.90	Level	9	0	0.957	1.00	4048
Ramp	454	0.90	Level	17	0	0.922	1.00	547
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 1.000 using Equation (Exhibit 13-7)

V_{12} = 4048 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	4048	Exhibit 13-8	4600	No
$V_{FO} = V_F - V_R$	3501	Exhibit 13-8	4600	No
V_R	547	Exhibit 13-10	2100	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	4048	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = 36.9 (pc/mi/ln)

LOS = E (Exhibit 13-2)

Speed Determination

D_s = 0.347 (Exhibit 13-12)

S_R= 53.7 mph (Exhibit 13-12)

S_0= N/A mph (Exhibit 13-12)

S = 53.7 mph (Exhibit 13-13)

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-526 WB*
Agency or Company	*Atkins*	From/To	*4135-ClFerry Off to ClFerry On*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2038 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*3058*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*13*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.939*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*60.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*60.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1809*	pc/h/ln
S	*59.2*	mph
D = v_p / S	*30.6*	pc/mi/ln
LOS	*D*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-526 WB*
Agency or Company	*Atkins*	From/To	*4135-ClFerry Off to ClFerry On*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*PM Peak*	Analysis Year	*2038 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*3032*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*12*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.943*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*60.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*60.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1786*	pc/h/ln
S	*59.4*	mph
D = v_p / S	*30.1*	pc/mi/ln
LOS	*D*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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FREEWAY RAMP ADD OR DROP LANE ANALYSIS

ATKINS

General Information

Date Performed:	7/25/2014	Freeway/Direction	I-526 WB
Analysis Year	2038 No Action	Junction	From Clements Ferry
Analysis Time Period:	AM Peak	Segment ID	4140
Project Description:	Navy Base ICTF		

Inputs

	Freeway Upstream of Ramp	Freeway Downstream of Ramp	Ramp
Number of Lanes, N	2	3	1
Free-Flow Speed, FFS (mph)	60	60	45
Volume, V (veh/h)	3,058	4,234	1,176
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	13%	13%	19%
%RVs, P_R	0%	0%	0%

Performance Measures

	Freeway Upstream Ramp	Freeway Downstream Ramp	Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.94	0.94	0.91
Demand Flow Rate, v_p (pc/h/ln)	1,809	1,670	1,431
Capacity Flow Rate, c (pc/h/ln)	2,300	2,300	2,100
v/c ratio	0.79	0.73	0.68
Density, D_{MD} (pc/mi/ln)	31.7	29.2	25.0
LOS	D	D	C

Formulas and Reference Material

$$f_{HV} = \frac{1}{1 + P_T(E_T-1)+P_R(E_R-1)}$$ HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P}$$ HCM 2010, Equation 11-2

$$D_{MD} = \frac{0.0175*v_f}{N}$$ HCM 2010, Equation 13-26

Basic Freeway Segments Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
75	2,400
70	2,400
65	2,350
60	2,300
55	2,250

Source: HCM 2010, Exhibit 11-17

Ramp Roadways Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

Diverge LOS Thresholds

LOS	Density (pc/mi/ln)
A	≤10
B	>10-20
C	>20-28
D	>28-35
E	>35
F	v/c > 1

Source: HCM 2010, Exhibit 13-2

FREEWAY RAMP ADD OR DROP LANE ANALYSIS

ATKINS

General Information

Date Performed:	7/25/2014	Freeway/Direction	I-526 WB
Analysis Year	2038 No Action	Junction	From Clements Ferry
Analysis Time Period:	PM Peak	Segment ID	4140
Project Description:	Navy Base ICTF		

Inputs

	Freeway Upstream of Ramp	Freeway Downstream of Ramp	Ramp
Number of Lanes, N	2	3	1
Free-Flow Speed, FFS (mph)	60	60	45
Volume, V (veh/h)	3,032	3,468	436
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	12%	12%	43%
%RVs, P_R	0%	0%	0%

Performance Measures

	Freeway Upstream Ramp	Freeway Downstream Ramp	Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.94	0.94	0.82
Demand Flow Rate, v_p (pc/h/ln)	1,786	1,362	589
Capacity Flow Rate, c (pc/h/ln)	2,300	2,300	2,100
v/c ratio	0.78	0.59	0.28
Density, D_{MD} (pc/mi/ln)	31.3	23.8	10.3
LOS	D	C	B

Formulas and Reference Material

$$f_{HV} = \frac{1}{1 + P_T(E_T-1)+P_R(E_R-1)}$$ HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P}$$ HCM 2010, Equation 11-2

$$D_{MD} = \frac{0.0175*v_f}{N}$$ HCM 2010, Equation 13-26

Basic Freeway Segments Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
75	2,400
70	2,400
65	2,350
60	2,300
55	2,250

Source: HCM 2010, Exhibit 11-17

Ramp Roadways Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

Diverge LOS Thresholds

LOS	Density (pc/mi/ln)
A	≤10
B	>10-20
C	>20-28
D	>28-35
E	>35
F	v/c > 1

Source: HCM 2010, Exhibit 13-2

BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-526 WB*
Agency or Company	*Atkins*	From/To	*4150-ClementsFerry to Virginia*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2038 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*4234*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*13*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.939*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*60.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*60.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*2505*	pc/h/ln
S	*45.1*	mph
D = v_p / S	*55.5*	pc/mi/ln
LOS	*F*	

Design (N)

Design (N)

Design LOS	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h/ln
S	mph
D = v_p / S	pc/mi/ln
Required Number of Lanes, N	

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-526 WB*
Agency or Company	*Atkins*	From/To	*4150-ClementsFerry to Virginia*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*PM Peak*	Analysis Year	*2038 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*3468*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*12*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.943*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*60.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*60.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*2042*	pc/h/ln
S	*56.5*	mph
D = v_p / S	*36.2*	pc/mi/ln
LOS	*E*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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Navy Base ICTF

FREEWAY WEAVING WORKSHEET

General Information

Analyst	AJR
Agency/Company	Atkins
Date Performed	7/25/2014
Analysis Time Period	AM Peak

Site Information

Freeway/Dir of Travel	I-526 WB
Weaving Segment Location	4160 - Virginia to Rhett
Analysis Year	2038 No Action

Project Description *Navy Base ICTF*

Inputs

Weaving configuration	One-Sided	Segment type	Freeway
Weaving number of lanes, N	3	Freeway minimum speed, S_{MIN}	15
Weaving segment length, L_S	1415ft	Freeway maximum capacity, C_{IFL}	2300
Freeway free-flow speed, FFS	60 mph	Terrain type	Level

Conversions to pc/h Under Base Conditions

	V (veh/h)	PHF	Truck (%)	RV (%)	E_T	E_R	f_{HV}	f_p	v (pc/h)
V_{FF}	3075	0.90	15	0	1.5	1.2	0.930	1.00	3673
V_{RF}	109	0.90	83	0	1.5	1.2	0.707	1.00	171
V_{FR}	1159	0.90	15	0	1.5	1.2	0.930	1.00	1384
V_{RR}	41	0.90	83	0	1.5	1.2	0.707	1.00	64
V_{NW}	3737							V =	5292
V_W	1555								
VR	0.294								

Configuration Characteristics

Minimum maneuver lanes, N_{WL}	2 lc	Minimum weaving lane changes, LC_{MIN}	1555 lc/h
Interchange density, ID	0.7 int/mi	Weaving lane changes, LC_W	1734 lc/h
Minimum RF lane changes, LC_{RF}	1 lc/pc	Non-weaving lane changes, LC_{NW}	959 lc/h
Minimum FR lane changes, LC_{FR}	1 lc/pc	Total lane changes, LC_{ALL}	2693 lc/h
Minimum RR lane changes, LC_{RR}	lc/pc	Non-weaving vehicle index, I_{NW}	370

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment flow rate, v	5292 pc/h	Weaving intensity factor, W	0.376
Weaving segment capacity, c_w	5542 veh/h	Weaving segment speed, S	42.3 mph
Weaving segment v/c ratio	0.888	Average weaving speed, S_W	47.7 mph
Weaving segment density, D	41.7 pc/mi/ln	Average non-weaving speed, S_{NW}	40.3 mph
Level of Service, LOS	E	Maximum weaving length, L_{MAX}	5518 ft

Notes

a. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments".
b. For volumes that exceed the weaving segment capacity, the level of service is "F".

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Navy Base ICTF

FREEWAY WEAVING WORKSHEET

General Information

Analyst	AJR
Agency/Company	Atkins
Date Performed	7/25/2014
Analysis Time Period	PM Peak

Site Information

Freeway/Dir of Travel	I-526 WB
Weaving Segment Location	4160 - Virginia to Rhett
Analysis Year	2038 No Action

Project Description *Navy Base ICTF*

Inputs

Weaving configuration	One-Sided	Segment type	Freeway
Weaving number of lanes, N	3	Freeway minimum speed, S_{MIN}	15
Weaving segment length, L_S	1415ft	Freeway maximum capacity, C_{IFL}	2300
Freeway free-flow speed, FFS	60 mph	Terrain type	Level

Conversions to pc/h Under Base Conditions

	V (veh/h)	PHF	Truck (%)	RV (%)	E_T	E_R	f_{HV}	f_p	v (pc/h)
V_{FF}	2354	0.90	14	0	1.5	1.2	0.935	1.00	2799
V_{RF}	576	0.90	14	0	1.5	1.2	0.935	1.00	685
V_{FR}	1114	0.90	14	0	1.5	1.2	0.935	1.00	1324
V_{RR}	272	0.90	13	0	1.5	1.2	0.939	1.00	322
V_{NW}	3121							V =	5130
V_W	2009								
VR	0.392								

Configuration Characteristics

Minimum maneuver lanes, N_{WL}	2 lc	Minimum weaving lane changes, LC_{MIN}	2009 lc/h
Interchange density, ID	0.7 int/mi	Weaving lane changes, LC_W	2188 lc/h
Minimum RF lane changes, LC_{RF}	1 lc/pc	Non-weaving lane changes, LC_{NW}	832 lc/h
Minimum FR lane changes, LC_{FR}	1 lc/pc	Total lane changes, LC_{ALL}	3020 lc/h
Minimum RR lane changes, LC_{RR}	lc/pc	Non-weaving vehicle index, I_{NW}	309

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment flow rate, v	5130 pc/h	Weaving intensity factor, W	0.411
Weaving segment capacity, c_w	5338 veh/h	Weaving segment speed, S	40.6 mph
Weaving segment v/c ratio	0.898	Average weaving speed, S_W	46.9 mph
Weaving segment density, D	42.2 pc/mi/ln	Average non-weaving speed, S_{NW}	37.3 mph
Level of Service, LOS	E	Maximum weaving length, L_{MAX}	6587 ft

Notes

a. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments".
b. For volumes that exceed the weaving segment capacity, the level of service is "F".

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-526 WB*
Agency or Company	*Atkins*	From/To	*4165-Rhett Off to Rhett On*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2038 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*3184*	veh/h	Peak-Hour Factor, PHF	*0.90*	
AADT		veh/day	%Trucks and Buses, P_T	*17*	
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*	
Peak-Hr Direction Prop, D			General Terrain:	*Level*	
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*	

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.922*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*60.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*60.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1919*	pc/h/ln
S	*58.2*	mph
D = v_p / S	*33.0*	pc/mi/ln
LOS	*D*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-526 WB*
Agency or Company	*Atkins*	From/To	*4165-Rhett Off to Rhett On*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*PM Peak*	Analysis Year	*2038 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*2930*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*15*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.930*

Speed Inputs			Calc Speed Adj and FFS		
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f_{LW}		mph
Number of Lanes, N	*2*		f_{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	*60.0*	mph	FFS	*60.0*	mph
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures			Design (N)	
Operational (LOS)			Design (N)	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1750*	pc/h/ln	Design LOS	
			v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h/ln
S	*59.6*	mph	S	mph
D = v_p / S	*29.4*	pc/mi/ln	D = v_p / S	pc/mi/ln
LOS	*D*		Required Number of Lanes, N	

Glossary		Factor Location	
N - Number of lanes	S - Speed	E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
V - Hourly volume	D - Density	E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 11-18	TRD - Page 11-11
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 11-2, 11-3	
DDHV - Directional design hour volume			

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F-3462

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-526 WB
Agency or Company	Atkins	Junction	4170-WB On from Rhett
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2038 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Number of Lanes, N: 2	☐ Yes ☐ On
☑ No ☐ Off	Acceleration Lane Length, L_A: 625	☑ No ☐ Off
L_{up} = ft	Deceleration Lane Length L_D:	L_{down} = ft
V_u = veh/h	Freeway Volume, V_F: 3184	V_D = veh/h
	Ramp Volume, V_R: 739	
	Freeway Free-Flow Speed, S_{FF}: 60.0	
	Ramp Free-Flow Speed, S_{FR}: 45.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	3184	0.90	Level	17	0	0.922	1.00	3838
Ramp	739	0.90	Level	6	0	0.971	1.00	846
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 1.000 using Equation (Exhibit 13-6)

V_{12} = 3838 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	4684	Exhibit 13-8		Yes

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	4684	Exhibit 13-8	4600:All	Yes

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = 37.7 (pc/mi/ln)

LOS = F (Exhibit 13-2)

Speed Determination

M_S = 0.687 (Exibit 13-11)

S_R= 47.6 mph (Exhibit 13-11)

S_0= N/A mph (Exhibit 13-11)

S = 47.6 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-526 WB
Agency or Company	Atkins	Junction	4170-WB On from Rhett
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2038 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Number of Lanes, N: 2	☐ Yes ☐ On
☑ No ☐ Off	Acceleration Lane Length, L_A: 625	☑ No ☐ Off
L_{up} = ft	Deceleration Lane Length L_D:	L_{down} = ft
V_u = veh/h	Freeway Volume, V_F: 2930	V_D = veh/h
	Ramp Volume, V_R: 609	
	Freeway Free-Flow Speed, S_{FF}: 60.0	
	Ramp Free-Flow Speed, S_{FR}: 45.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	2930	0.90	Level	15	0	0.930	1.00	3500
Ramp	609	0.90	Level	6	0	0.971	1.00	697
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 1.000 using Equation (Exhibit 13-6)

V_{12} = 3500 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	4197	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	4197	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = 34.0 (pc/mi/ln)

LOS = D (Exhibit 13-2)

Speed Determination

M_S = 0.524 (Exibit 13-11)

S_R= 50.6 mph (Exhibit 13-11)

S_0= N/A mph (Exhibit 13-11)

S = 50.6 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-526 WB*
Agency or Company	*Atkins*	From/To	*4180-Rhett to Rivers*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2038 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*3923*	veh/h	Peak-Hour Factor, PHF	*0.90*	
AADT		veh/day	%Trucks and Buses, P_T	*17*	
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*	
Peak-Hr Direction Prop, D			General Terrain:	*Level*	
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*	

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.922*

Speed Inputs			Calc Speed Adj and FFS		
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f_{LW}		mph
Number of Lanes, N	*2*		f_{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	*55.0*	mph	FFS	*55.0*	mph
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures			Design (N)	
Operational (LOS)			Design (N)	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*2365*	pc/h/ln	Design LOS	
S	*47.1*	mph	v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h/ln
D = v_p / S	*50.2*	pc/mi/ln	S	mph
LOS	*F*		D = v_p / S	pc/mi/ln
			Required Number of Lanes, N	

Glossary		Factor Location	
N - Number of lanes	S - Speed	E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
V - Hourly volume	D - Density	E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 11-18	TRD - Page 11-11
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 11-2, 11-3	
DDHV - Directional design hour volume			

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-526 WB*
Agency or Company	*Atkins*	From/To	*4180-Rhett to Rivers*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*PM Peak*	Analysis Year	*2038 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*3539*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*15*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.930*

Speed Inputs			Calc Speed Adj and FFS		
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f_{LW}		mph
Number of Lanes, N	*2*		f_{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	*55.0*	mph	FFS	*55.0*	mph
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures			Design (N)	
Operational (LOS)			Design (N)	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*2114*	pc/h/ln	Design LOS	
			v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h/ln
S	*52.6*	mph	S	mph
D = v_p / S	*40.2*	pc/mi/ln	D = v_p / S	pc/mi/ln
LOS	*E*		Required Number of Lanes, N	

Glossary		Factor Location	
N - Number of lanes	S - Speed	E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
V - Hourly volume	D - Density	E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 11-18	TRD - Page 11-11
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 11-2, 11-3	
DDHV - Directional design hour volume			

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-526 WB
Agency or Company	Atkins	Junction	4190-WB Off to Rivers NB
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2038 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Number of Lanes, N	2	Downstream Adj Ramp	
☐ Yes	☐ On	Acceleration Lane Length, L_A		☐ Yes	☐ On
☑ No	☐ Off	Deceleration Lane Length L_D	725	☑ No	☐ Off
L_{up} =	ft	Freeway Volume, V_F	3923	L_{down} =	ft
V_u =	veh/h	Ramp Volume, V_R	328	V_D =	veh/h
		Freeway Free-Flow Speed, S_{FF}	55.0		
		Ramp Free-Flow Speed, S_{FR}	45.0		

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	3923	0.90	Level	17	0	0.922	1.00	4729
Ramp	328	0.90	Level	14	0	0.935	1.00	390
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 1.000 using Equation (Exhibit 13-7)

V_{12} = 4729 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	4729	Exhibit 13-8	4500	Yes
$V_{FO} = V_F - V_R$	4339	Exhibit 13-8	4500	No
V_R	390	Exhibit 13-10	2100	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	4729	Exhibit 13-8	4400:All	Yes

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = 38.4 (pc/mi/ln)

LOS = F (Exhibit 13-2)

Speed Determination

D_s = 0.333 (Exhibit 13-12)

S_R= 50.7 mph (Exhibit 13-12)

S_0= N/A mph (Exhibit 13-12)

S = 50.7 mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-526 WB
Agency or Company	Atkins	Junction	4190-WB Off to Rivers NB
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2038 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Number of Lanes, N: 2	☐ Yes ☐ On
☑ No ☐ Off	Acceleration Lane Length, L_A	☑ No ☐ Off
L_{up} = ft	Deceleration Lane Length L_D: 725	L_{down} = ft
V_u = veh/h	Freeway Volume, V_F: 3539	V_D = veh/h
	Ramp Volume, V_R: 237	
	Freeway Free-Flow Speed, S_{FF}: 55.0	
	Ramp Free-Flow Speed, S_{FR}: 45.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	3539	0.90	Level	15	0	0.930	1.00	4227
Ramp	237	0.90	Level	17	0	0.922	1.00	286
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 1.000 using Equation (Exhibit 13-7)

V_{12} = 4227 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	4227	Exhibit 13-8	4500	No
$V_{FO} = V_F - V_R$	3941	Exhibit 13-8	4500	No
V_R	286	Exhibit 13-10	2100	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	4227	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = 34.1 (pc/mi/ln)

LOS = D (Exhibit 13-2)

Speed Determination

D_s = 0.324 (Exhibit 13-12)

S_R= 50.8 mph (Exhibit 13-12)

S_0= N/A mph (Exhibit 13-12)

S = 50.8 mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-526 WB
Agency or Company	Atkins	Junction	4200-WB Off to Rivers SB
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2038 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Number of Lanes, N: 2	☐ Yes ☐ On
☑ No ☐ Off	Acceleration Lane Length, L_A	☑ No ☐ Off
L_{up} = ft	Deceleration Lane Length L_D: 700	L_{down} = ft
V_u = veh/h	Freeway Volume, V_F: 3595	V_D = veh/h
	Ramp Volume, V_R: 235	
	Freeway Free-Flow Speed, S_{FF}: 55.0	
	Ramp Free-Flow Speed, S_{FR}: 25.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	3595	0.90	Level	17	0	0.922	1.00	4334
Ramp	235	0.90	Level	6	0	0.971	1.00	269
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 1.000 using Equation (Exhibit 13-7)

V_{12} = 4334 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	4334	Exhibit 13-8	4500	No
$V_{FO} = V_F - V_R$	4065	Exhibit 13-8	4500	No
V_R	269	Exhibit 13-10	1900	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	4334	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = 35.2 (pc/mi/ln)

LOS = E (Exhibit 13-2)

Speed Determination

D_s = 0.582 (Exhibit 13-12)

S_R= 47.4 mph (Exhibit 13-12)

S_0= N/A mph (Exhibit 13-12)

S = 47.4 mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-526 WB
Agency or Company	Atkins	Junction	4200-WB Off to Rivers SB
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2038 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Number of Lanes, N: 2	☐ Yes ☐ On
☑ No ☐ Off	Acceleration Lane Length, L_A:	☑ No ☐ Off
L_{up} = ft	Deceleration Lane Length L_D: 700	L_{down} = ft
V_u = veh/h	Freeway Volume, V_F: 3302	V_D = veh/h
	Ramp Volume, V_R: 71	
	Freeway Free-Flow Speed, S_{FF}: 55.0	
	Ramp Free-Flow Speed, S_{FR}: 25.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	3302	0.90	Level	15	0	0.930	1.00	3944
Ramp	71	0.90	Level	15	0	0.930	1.00	85
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 1.000 using Equation (Exhibit 13-7)

V_{12} = 3944 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	3944	Exhibit 13-8	4500	No
$V_{FO} = V_F - V_R$	3859	Exhibit 13-8	4500	No
V_R	85	Exhibit 13-10	1900	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	3944	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = 31.9 (pc/mi/ln)

LOS = D (Exhibit 13-2)

Speed Determination

D_s = 0.566 (Exhibit 13-12)

S_R= 47.6 mph (Exhibit 13-12)

S_0= N/A mph (Exhibit 13-12)

S = 47.6 mph (Exhibit 13-13)

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-526 WB*
Agency or Company	*Atkins*	From/To	*4205-RiversSB Off to Rivers On*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2038 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*3360*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*17*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.922*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*55.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*55.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*2025*	pc/h/ln
S	*53.8*	mph
D = v_p / S	*37.7*	pc/mi/ln
LOS	*E*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-526 WB*
Agency or Company	*Atkins*	From/To	*4205-RiversSB Off to Rivers On*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*PM Peak*	Analysis Year	*2038 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*3231*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*15*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.930*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*55.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*55.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1930*	pc/h/ln
S	*54.6*	mph
D = v_p / S	*35.4*	pc/mi/ln
LOS	*E*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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Navy Base ICTF

FREEWAY WEAVING WORKSHEET

General Information

Analyst	AJR
Agency/Company	Atkins
Date Performed	7/25/2014
Analysis Time Period	AM Peak

Site Information

Freeway/Dir of Travel	I-526 WB
Weaving Segment Location	4210 - Rivers to I-26 WB
Analysis Year	2038 No Action

Project Description *Navy Base ICTF*

Inputs

Weaving configuration	One-Sided
Weaving number of lanes, N	3
Weaving segment length, L_S	725ft
Freeway free-flow speed, FFS	55 mph
Segment type	Freeway
Freeway minimum speed, S_{MIN}	15
Freeway maximum capacity, C_{IFL}	2250
Terrain type	Level

Conversions to pc/h Under Base Conditions

	V (veh/h)	PHF	Truck (%)	RV (%)	E_T	E_R	f_{HV}	f_p	v (pc/h)
V_{FF}	2203	0.90	17	0	1.5	1.2	0.922	1.00	2656
V_{RF}	382	0.90	17	0	1.5	1.2	0.922	1.00	461
V_{FR}	1157	0.90	54	0	1.5	1.2	0.787	1.00	1633
V_{RR}	200	0.90	54	0	1.5	1.2	0.787	1.00	282
V_{NW}	2938							V =	5032
V_W	2094								
VR	0.416								

Configuration Characteristics

Minimum maneuver lanes, N_{WL}	2 lc	Minimum weaving lane changes, LC_{MIN}	2094 lc/h
Interchange density, ID	1.2 int/mi	Weaving lane changes, LC_W	2230 lc/h
Minimum RF lane changes, LC_{RF}	1 lc/pc	Non-weaving lane changes, LC_{NW}	420 lc/h
Minimum FR lane changes, LC_{FR}	1 lc/pc	Total lane changes, LC_{ALL}	2650 lc/h
Minimum RR lane changes, LC_{RR}	lc/pc	Non-weaving vehicle index, I_{NW}	256

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment flow rate, v	5032 pc/h	Weaving intensity factor, W	0.628
Weaving segment capacity, c_w	4922 veh/h	Weaving segment speed, S	34.7 mph
Weaving segment v/c ratio	0.942	Average weaving speed, S_W	39.6 mph
Weaving segment density, D	48.4 pc/mi/ln	Average non-weaving speed, S_{NW}	31.9 mph
Level of Service, LOS	E	Maximum weaving length, L_{MAX}	6863 ft

Notes

a. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments".
b. For volumes that exceed the weaving segment capacity, the level of service is "F".

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Navy Base ICTF

FREEWAY WEAVING WORKSHEET

General Information

Analyst	AJR
Agency/Company	Atkins
Date Performed	7/25/2014
Analysis Time Period	PM Peak

Site Information

Freeway/Dir of Travel	I-526 WB
Weaving Segment Location	4210 - Rivers to I-26 WB
Analysis Year	2038 No Action

Project Description *Navy Base ICTF*

Inputs

Weaving configuration	One-Sided	Segment type	Freeway
Weaving number of lanes, N	3	Freeway minimum speed, S_{MIN}	15
Weaving segment length, L_S	725ft	Freeway maximum capacity, C_{IFL}	2250
Freeway free-flow speed, FFS	55 mph	Terrain type	Level

Conversions to pc/h Under Base Conditions

	V (veh/h)	PHF	Truck (%)	RV (%)	E_T	E_R	f_{HV}	f_p	v (pc/h)
V_{FF}	1827	0.90	15	0	1.5	1.2	0.930	1.00	2182
V_{RF}	299	0.90	15	0	1.5	1.2	0.930	1.00	357
V_{FR}	1404	0.90	39	0	1.5	1.2	0.837	1.00	1864
V_{RR}	230	0.90	39	0	1.5	1.2	0.837	1.00	305
V_{NW}	2487							V =	4708
V_W	2221								
VR	0.472								

Configuration Characteristics

Minimum maneuver lanes, N_{WL}	2 lc	Minimum weaving lane changes, LC_{MIN}	2221 lc/h
Interchange density, ID	1.2 int/mi	Weaving lane changes, LC_W	2357 lc/h
Minimum RF lane changes, LC_{RF}	1 lc/pc	Non-weaving lane changes, LC_{NW}	327 lc/h
Minimum FR lane changes, LC_{FR}	1 lc/pc	Total lane changes, LC_{ALL}	2684 lc/h
Minimum RR lane changes, LC_{RR}	lc/pc	Non-weaving vehicle index, I_{NW}	216

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment flow rate, v	4708 pc/h	Weaving intensity factor, W	0.635
Weaving segment capacity, c_w	4733 veh/h	Weaving segment speed, S	34.8 mph
Weaving segment v/c ratio	0.925	Average weaving speed, S_W	39.5 mph
Weaving segment density, D	45.1 pc/mi/ln	Average non-weaving speed, S_{NW}	31.5 mph
Level of Service, LOS	E	Maximum weaving length, L_{MAX}	7498 ft

Notes

a. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments".
b. For volumes that exceed the weaving segment capacity, the level of service is "F".

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-526 WB*
Agency or Company	*Atkins*	From/To	*4215-I-26 WB Off to I-26 WB On*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2038 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*2585*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*17*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.922*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*55.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*55.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1558*	pc/h/ln
S	*55.0*	mph
D = v_p / S	*28.3*	pc/mi/ln
LOS	*D*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-526 WB*
Agency or Company	*Atkins*	From/To	*4215-I-26 WB Off to I-26 WB On*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*PM Peak*	Analysis Year	*2038 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*2126*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*15*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.930*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*55.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*55.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1270*	pc/h/ln
S	*55.0*	mph
D = v_p / S	*23.1*	pc/mi/ln
LOS	*C*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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Navy Base ICTF

FREEWAY WEAVING WORKSHEET

General Information

Analyst	AJR
Agency/Company	Atkins
Date Performed	7/25/2014
Analysis Time Period	AM Peak

Site Information

Freeway/Dir of Travel	I-526 WB
Weaving Segment Location	4220 - I-26 WB to I-26 EB C-D
Analysis Year	2038 No Action

Project Description *Navy Base ICTF*

Inputs

Weaving configuration	One-Sided
Weaving number of lanes, N	3
Weaving segment length, L_S	550ft
Freeway free-flow speed, FFS	55 mph
Segment type	Freeway
Freeway minimum speed, S_{MIN}	15
Freeway maximum capacity, C_{IFL}	2250
Terrain type	Level

Conversions to pc/h Under Base Conditions

	V (veh/h)	PHF	Truck (%)	RV (%)	E_T	E_R	f_{HV}	fp	v (pc/h)
V_{FF}	2019	0.90	17	0	1.5	1.2	0.922	1.00	2434
V_{RF}	275	0.90	7	0	1.5	1.2	0.966	1.00	316
V_{FR}	566	0.90	8	0	1.5	1.2	0.962	1.00	654
V_{RR}	0	0.90	0	0	1.5	1.2	1.000	1.00	0
V_{NW}	2434							V =	3404
V_W	970								
VR	0.285								

Configuration Characteristics

Minimum maneuver lanes, N_{WL}	2 lc	Minimum weaving lane changes, LC_{MIN}	970 lc/h
Interchange density, ID	1.2 int/mi	Weaving lane changes, LC_W	1074 lc/h
Minimum RF lane changes, LC_{RF}	1 lc/pc	Non-weaving lane changes, LC_{NW}	222 lc/h
Minimum FR lane changes, LC_{FR}	1 lc/pc	Total lane changes, LC_{ALL}	1296 lc/h
Minimum RR lane changes, LC_{RR}	lc/pc	Non-weaving vehicle index, I_{NW}	161

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment flow rate, v	3404 pc/h	Weaving intensity factor, W	0.444
Weaving segment capacity, c_w	5190 veh/h	Weaving segment speed, S	42.6 mph
Weaving segment v/c ratio	0.604	Average weaving speed, S_W	42.7 mph
Weaving segment density, D	26.6 pc/mi/ln	Average non-weaving speed, S_{NW}	42.6 mph
Level of Service, LOS	C	Maximum weaving length, L_{MAX}	5423 ft

Notes

a. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments".
b. For volumes that exceed the weaving segment capacity, the level of service is "F".

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Navy Base ICTF

FREEWAY WEAVING WORKSHEET

General Information

Analyst	AJR
Agency/Company	Atkins
Date Performed	7/25/2014
Analysis Time Period	PM Peak

Site Information

Freeway/Dir of Travel	I-526 WB
Weaving Segment Location	4220 - I-26 WB to I-26 EB C-D
Analysis Year	2038 No Action

Project Description *Navy Base ICTF*

Inputs

Weaving configuration	One-Sided
Weaving number of lanes, N	3
Weaving segment length, L_S	550ft
Freeway free-flow speed, FFS	55 mph
Segment type	Freeway
Freeway minimum speed, S_{MIN}	15
Freeway maximum capacity, C_{IFL}	2250
Terrain type	Level

Conversions to pc/h Under Base Conditions

	V (veh/h)	PHF	Truck (%)	RV (%)	E_T	E_R	f_{HV}	fp	v (pc/h)
V_{FF}	1628	0.90	15	0	1.5	1.2	0.930	1.00	1945
V_{RF}	338	0.90	5	0	1.5	1.2	0.976	1.00	385
V_{FR}	498	0.90	7	0	1.5	1.2	0.966	1.00	573
V_{RR}	0	0.90	0	0	1.5	1.2	1.000	1.00	0
V_{NW}	1945							V =	2903
V_W	958								
VR	0.330								

Configuration Characteristics

Minimum maneuver lanes, N_{WL}	2 lc	Minimum weaving lane changes, LC_{MIN}	958 lc/h
Interchange density, ID	1.2 int/mi	Weaving lane changes, LC_W	1062 lc/h
Minimum RF lane changes, LC_{RF}	1 lc/pc	Non-weaving lane changes, LC_{NW}	121 lc/h
Minimum FR lane changes, LC_{FR}	1 lc/pc	Total lane changes, LC_{ALL}	1183 lc/h
Minimum RR lane changes, LC_{RR}	lc/pc	Non-weaving vehicle index, I_{NW}	128

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment flow rate, v	2903 pc/h	Weaving intensity factor, W	0.414
Weaving segment capacity, c_w	5135 veh/h	Weaving segment speed, S	43.4 mph
Weaving segment v/c ratio	0.526	Average weaving speed, S_W	43.3 mph
Weaving segment density, D	22.3 pc/mi/ln	Average non-weaving speed, S_{NW}	43.5 mph
Level of Service, LOS	C	Maximum weaving length, L_{MAX}	5908 ft

Notes

a. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments".
b. For volumes that exceed the weaving segment capacity, the level of service is "F".

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-526 WB*
Agency or Company	*Atkins*	From/To	*4225-I-26 EB CD Off to On*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2038 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*2294*	veh/h	Peak-Hour Factor, PHF	*0.90*	
AADT		veh/day	%Trucks and Buses, P_T	*17*	
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*	
Peak-Hr Direction Prop, D			General Terrain:	*Level*	
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*	

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.922*

Speed Inputs			Calc Speed Adj and FFS		
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f_{LW}		mph
Number of Lanes, N	*2*		f_{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	*55.0*	mph	FFS	*55.0*	mph
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures			Design (N)	
Operational (LOS)			Design (N)	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1383*	pc/h/ln	Design LOS	
S	*55.0*	mph	v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h/ln
D = v_p / S	*25.1*	pc/mi/ln	S	mph
LOS	*C*		D = v_p / S	pc/mi/ln
			Required Number of Lanes, N	

Glossary		Factor Location	
N - Number of lanes	S - Speed	E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
V - Hourly volume	D - Density	E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 11-18	TRD - Page 11-11
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 11-2, 11-3	
DDHV - Directional design hour volume			

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-526 WB*
Agency or Company	*Atkins*	From/To	*4225-I-26 EB CD Off to On*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*PM Peak*	Analysis Year	*2038 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*1966*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*15*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.930*

Speed Inputs			Calc Speed Adj and FFS		
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f_{LW}		mph
Number of Lanes, N	*2*		f_{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	*55.0*	mph	FFS	*55.0*	mph
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures			Design (N)	
Operational (LOS)			Design (N)	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1174*	pc/h/ln	Design LOS	
			v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h/ln
S	*55.0*	mph	S	mph
D = v_p / S	*21.3*	pc/mi/ln	D = v_p / S	pc/mi/ln
LOS	*C*		Required Number of Lanes, N	

Glossary		Factor Location	
N - Number of lanes	S - Speed	E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
V - Hourly volume	D - Density	E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 11-18	TRD - Page 11-11
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 11-2, 11-3	
DDHV - Directional design hour volume			

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Navy Base ICTF

FREEWAY WEAVING WORKSHEET

General Information

Analyst	AJR
Agency/Company	Atkins
Date Performed	7/25/2014
Analysis Time Period	AM Peak

Site Information

Freeway/Dir of Travel	I-526 WB
Weaving Segment Location	4230-I-26EBCD to International
Analysis Year	2038 No Action

Project Description *Navy Base ICTF*

Inputs

Weaving configuration	One-Sided	Segment type	Freeway
Weaving number of lanes, N	3	Freeway minimum speed, S_{MIN}	15
Weaving segment length, L_S	3135ft	Freeway maximum capacity, C_{IFL}	2300
Freeway free-flow speed, FFS	60 mph	Terrain type	Level

Conversions to pc/h Under Base Conditions

	V (veh/h)	PHF	Truck (%)	RV (%)	E_T	E_R	f_{HV}	f_p	v (pc/h)
V_{FF}	1411	0.90	9	0	1.5	1.2	0.957	1.00	1638
V_{RF}	1548	0.90	17	0	1.5	1.2	0.922	1.00	1866
V_{FR}	883	0.90	9	0	1.5	1.2	0.957	1.00	1025
V_{RR}	970	0.90	17	0	1.5	1.2	0.922	1.00	1169
V_{NW}	2807							V =	5698
V_W	2891								
VR	0.507								

Configuration Characteristics

Minimum maneuver lanes, N_{WL}	2 lc	Minimum weaving lane changes, LC_{MIN}	lc/h
Interchange density, ID	1.0 int/mi	Weaving lane changes, LC_W	lc/h
Minimum RF lane changes, LC_{RF}	1 lc/pc	Non-weaving lane changes, LC_{NW}	lc/h
Minimum FR lane changes, LC_{FR}	1 lc/pc	Total lane changes, LC_{ALL}	lc/h
Minimum RR lane changes, LC_{RR}	lc/pc	Non-weaving vehicle index, I_{NW}	492

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment flow rate, v	5698 pc/h	Weaving intensity factor, W	
Weaving segment capacity, c_w	4527 veh/h	Weaving segment speed, S	mph
Weaving segment v/c ratio	1.204	Average weaving speed, S_W	mph
Weaving segment density, D	pc/mi/ln	Average non-weaving speed, S_{NW}	mph
Level of Service, LOS	F	Maximum weaving length, L_{MAX}	7913 ft

Notes

a. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments".
b. For volumes that exceed the weaving segment capacity, the level of service is "F".

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Navy Base ICTF

FREEWAY WEAVING WORKSHEET

General Information

Analyst	AJR
Agency/Company	Atkins
Date Performed	7/25/2014
Analysis Time Period	PM Peak

Site Information

Freeway/Dir of Travel	I-526 WB
Weaving Segment Location	4230-I-26EBCD to International
Analysis Year	2038 No Action

Project Description *Navy Base ICTF*

Inputs

Weaving configuration	One-Sided	Segment type	Freeway
Weaving number of lanes, N	3	Freeway minimum speed, S_{MIN}	15
Weaving segment length, L_S	3135ft	Freeway maximum capacity, C_{IFL}	2300
Freeway free-flow speed, FFS	60 mph	Terrain type	Level

Conversions to pc/h Under Base Conditions

	V (veh/h)	PHF	Truck (%)	RV (%)	E_T	E_R	f_{HV}	f_p	v (pc/h)
V_{FF}	927	0.90	7	0	1.5	1.2	0.966	1.00	1066
V_{RF}	952	0.90	18	0	1.5	1.2	0.917	1.00	1153
V_{FR}	1039	0.90	7	0	1.5	1.2	0.966	1.00	1195
V_{RR}	1067	0.90	18	0	1.5	1.2	0.917	1.00	1292
V_{NW}	2358							V =	4706
V_W	2348								
VR	0.499								

Configuration Characteristics

Minimum maneuver lanes, N_{WL}	2 lc	Minimum weaving lane changes, LC_{MIN}	2348 lc/h
Interchange density, ID	1.0 int/mi	Weaving lane changes, LC_W	2673 lc/h
Minimum RF lane changes, LC_{RF}	1 lc/pc	Non-weaving lane changes, LC_{NW}	1607 lc/h
Minimum FR lane changes, LC_{FR}	1 lc/pc	Total lane changes, LC_{ALL}	4280 lc/h
Minimum RR lane changes, LC_{RR}	lc/pc	Non-weaving vehicle index, I_{NW}	739

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment flow rate, v	4706 pc/h	Weaving intensity factor, W	0.289
Weaving segment capacity, c_w	4648 veh/h	Weaving segment speed, S	41.5 mph
Weaving segment v/c ratio	0.978	Average weaving speed, S_W	49.9 mph
Weaving segment density, D	37.8 pc/mi/ln	Average non-weaving speed, S_{NW}	35.6 mph
Level of Service, LOS	E	Maximum weaving length, L_{MAX}	7814 ft

Notes

a. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments".
b. For volumes that exceed the weaving segment capacity, the level of service is "F".

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-526 WB*
Agency or Company	*Atkins*	From/To	*4235-Interna Off to Interna On*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2038 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs				
Volume, V	*2959*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*9*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.957*

Speed Inputs			Calc Speed Adj and FFS		
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f_{LW}		mph
Number of Lanes, N	*2*		f_{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	*60.0*	mph	FFS	*60.0*	mph
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures			Design (N)	
Operational (LOS)			Design (N)	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1718*	pc/h/ln	Design LOS	
			v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h/ln
S	*59.7*	mph	S	mph
D = v_p / S	*28.8*	pc/mi/ln	D = v_p / S	pc/mi/ln
LOS	*D*		Required Number of Lanes, N	

Glossary		Factor Location	
N - Number of lanes	S - Speed	E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
V - Hourly volume	D - Density	E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 11-18	TRD - Page 11-11
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 11-2, 11-3	
DDHV - Directional design hour volume			

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-526 WB*
Agency or Company	*Atkins*	From/To	*4235-Interna Off to Interna On*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*PM Peak*	Analysis Year	*2038 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*1879*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*8*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.962*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*60.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*60.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1086*	pc/h/ln
S	*60.0*	mph
D = v_p / S	*18.1*	pc/mi/ln
LOS	*C*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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F-3484

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-526 WB
Agency or Company	Atkins	Junction	4240-WB On from International
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2038 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Number of Lanes, N: 2	☐ Yes ☐ On
☑ No ☐ Off	Acceleration Lane Length, L_A: 875	☑ No ☐ Off
L_{up} = ft	Deceleration Lane Length L_D:	L_{down} = ft
V_u = veh/h	Freeway Volume, V_F: 2959	V_D = veh/h
	Ramp Volume, V_R: 621	
	Freeway Free-Flow Speed, S_{FF}: 60.0	
	Ramp Free-Flow Speed, S_{FR}: 45.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	2959	0.90	Level	9	0	0.957	1.00	3436
Ramp	621	0.90	Level	17	0	0.922	1.00	749
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 1.000 using Equation (Exhibit 13-6)

V_{12} = 3436 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	4185	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	4185	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = 32.3 (pc/mi/ln)

LOS = D (Exhibit 13-2)

Speed Determination

M_S = 0.498 (Exibit 13-11)

S_R= 51.0 mph (Exhibit 13-11)

S_0= N/A mph (Exhibit 13-11)

S = 51.0 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-526 WB
Agency or Company	Atkins	Junction	4240-WB On from International
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2038 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Number of Lanes, N: 2	☐ Yes ☐ On
☑ No ☐ Off	Acceleration Lane Length, L_A: 875	☑ No ☐ Off
L_{up} = ft	Deceleration Lane Length L_D:	L_{down} = ft
V_u = veh/h	Freeway Volume, V_F: 1879	V_D = veh/h
	Ramp Volume, V_R: 928	
	Freeway Free-Flow Speed, S_{FF}: 60.0	
	Ramp Free-Flow Speed, S_{FR}: 45.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	1879	0.90	Level	8	0	0.962	1.00	2171
Ramp	928	0.90	Level	10	0	0.952	1.00	1083
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 1.000 using Equation (Exhibit 13-6)

V_{12} = 2171 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	3254	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	3254	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = 24.9 (pc/mi/ln)

LOS = C (Exhibit 13-2)

Speed Determination

M_S = 0.343 (Exibit 13-11)

S_R= 53.8 mph (Exhibit 13-11)

S_0= N/A mph (Exhibit 13-11)

S = 53.8 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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Navy Base ICTF

FREEWAY WEAVING WORKSHEET

General Information

Analyst	AJR
Agency/Company	Atkins
Date Performed	7/25/2014
Analysis Time Period	AM Peak

Site Information

Freeway/Dir of Travel	I-526 WB
Weaving Segment Location	4250-Montague to Dorchester
Analysis Year	2038 No Action

Project Description *Navy Base ICTF*

Inputs

Weaving configuration	One-Sided	Segment type	Freeway
Weaving number of lanes, N	3	Freeway minimum speed, S_{MIN}	15
Weaving segment length, L_S	950ft	Freeway maximum capacity, C_{IFL}	2300
Freeway free-flow speed, FFS	60 mph	Terrain type	Level

Conversions to pc/h Under Base Conditions

	V (veh/h)	PHF	Truck (%)	RV (%)	E_T	E_R	f_{HV}	f_p	v (pc/h)
V_{FF}	2762	0.90	9	0	1.5	1.2	0.957	1.00	3207
V_{RF}	539	0.90	9	0	1.5	1.2	0.957	1.00	626
V_{FR}	818	0.90	13	0	1.5	1.2	0.939	1.00	968
V_{RR}	159	0.90	13	0	1.5	1.2	0.939	1.00	188
V_{NW}	3395							V =	4989
V_W	1594								
VR	0.320								

Configuration Characteristics

Minimum maneuver lanes, N_{WL}	2 lc	Minimum weaving lane changes, LC_{MIN}	1594 lc/h
Interchange density, ID	1.0 int/mi	Weaving lane changes, LC_W	1750 lc/h
Minimum RF lane changes, LC_{RF}	1 lc/pc	Non-weaving lane changes, LC_{NW}	636 lc/h
Minimum FR lane changes, LC_{FR}	1 lc/pc	Total lane changes, LC_{ALL}	2386 lc/h
Minimum RR lane changes, LC_{RR}	lc/pc	Non-weaving vehicle index, I_{NW}	323

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment flow rate, v	4989 pc/h	Weaving intensity factor, W	0.467
Weaving segment capacity, c_w	5538 veh/h	Weaving segment speed, S	42.0 mph
Weaving segment v/c ratio	0.862	Average weaving speed, S_W	45.7 mph
Weaving segment density, D	39.5 pc/mi/ln	Average non-weaving speed, S_{NW}	40.5 mph
Level of Service, LOS	E	Maximum weaving length, L_{MAX}	5794 ft

Notes

a. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments".
b. For volumes that exceed the weaving segment capacity, the level of service is "F".

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Navy Base ICTF

FREEWAY WEAVING WORKSHEET

General Information

Analyst	AJR
Agency/Company	Atkins
Date Performed	7/25/2014
Analysis Time Period	PM Peak

Site Information

Freeway/Dir of Travel	I-526 WB
Weaving Segment Location	4250-Montague to Dorchester
Analysis Year	2038 No Action

Project Description *Navy Base ICTF*

Inputs

Weaving configuration	One-Sided	Segment type	Freeway
Weaving number of lanes, N	3	Freeway minimum speed, S_{MIN}	15
Weaving segment length, L_S	950ft	Freeway maximum capacity, C_{IFL}	2300
Freeway free-flow speed, FFS	60 mph	Terrain type	Level

Conversions to pc/h Under Base Conditions

	V (veh/h)	PHF	Truck (%)	RV (%)	E_T	E_R	f_{HV}	f_p	v (pc/h)
V_{FF}	2237	0.90	8	0	1.5	1.2	0.962	1.00	2585
V_{RF}	752	0.90	8	0	1.5	1.2	0.962	1.00	869
V_{FR}	570	0.90	15	0	1.5	1.2	0.930	1.00	681
V_{RR}	191	0.90	15	0	1.5	1.2	0.930	1.00	228
V_{NW}	2813							V =	4363
V_W	1550								
VR	0.355								

Configuration Characteristics

Minimum maneuver lanes, N_{WL}	2 lc	Minimum weaving lane changes, LC_{MIN}	1550 lc/h
Interchange density, ID	1.0 int/mi	Weaving lane changes, LC_W	1706 lc/h
Minimum RF lane changes, LC_{RF}	1 lc/pc	Non-weaving lane changes, LC_{NW}	517 lc/h
Minimum FR lane changes, LC_{FR}	1 lc/pc	Total lane changes, LC_{ALL}	2223 lc/h
Minimum RR lane changes, LC_{RR}	lc/pc	Non-weaving vehicle index, I_{NW}	267

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment flow rate, v	4363 pc/h	Weaving intensity factor, W	0.442
Weaving segment capacity, c_w	5481 veh/h	Weaving segment speed, S	43.3 mph
Weaving segment v/c ratio	0.765	Average weaving speed, S_W	46.2 mph
Weaving segment density, D	33.6 pc/mi/ln	Average non-weaving speed, S_{NW}	41.9 mph
Level of Service, LOS	D	Maximum weaving length, L_{MAX}	6184 ft

Notes

a. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments".
b. For volumes that exceed the weaving segment capacity, the level of service is "F".

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-526 WB*
Agency or Company	*Atkins*	From/To	*4255-Dorches Off to Dorches On*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2038 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*3301*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*9*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.957*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*60.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*60.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1916*	pc/h/ln
S	*58.2*	mph
D = v_p / S	*32.9*	pc/mi/ln
LOS	*D*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-526 WB*
Agency or Company	*Atkins*	From/To	*4255-Dorches Off to Dorches On*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*PM Peak*	Analysis Year	*2038 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*2989*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*8*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.962*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*60.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*60.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1727*	pc/h/ln
S	*59.7*	mph
D = v_p / S	*28.9*	pc/mi/ln
LOS	*D*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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Navy Base ICTF

FREEWAY WEAVING WORKSHEET

General Information

Analyst	AJR
Agency/Company	Atkins
Date Performed	7/25/2014
Analysis Time Period	AM Peak

Site Information

Freeway/Dir of Travel	I-526 WB
Weaving Segment Location	4260-Dorchester to Leeds
Analysis Year	2038 No Action

Project Description *Navy Base ICTF*

Inputs

Weaving configuration	One-Sided	Segment type	Freeway
Weaving number of lanes, N	3	Freeway minimum speed, S_{MIN}	15
Weaving segment length, L_S	1750ft	Freeway maximum capacity, C_{IFL}	2300
Freeway free-flow speed, FFS	60 mph	Terrain type	Level

Conversions to pc/h Under Base Conditions

	V (veh/h)	PHF	Truck (%)	RV (%)	E_T	E_R	f_{HV}	f_p	v (pc/h)
V_{FF}	2381	0.90	8	0	1.5	1.2	0.962	1.00	2751
V_{RF}	461	0.90	17	0	1.5	1.2	0.922	1.00	556
V_{FR}	920	0.90	17	0	1.5	1.2	0.922	1.00	1109
V_{RR}	178	0.90	17	0	1.5	1.2	0.922	1.00	215
V_{NW}	2966							V =	4631
V_W	1665								
VR	0.360								

Configuration Characteristics

Minimum maneuver lanes, N_{WL}	2 lc	Minimum weaving lane changes, LC_{MIN}	1665 lc/h
Interchange density, ID	1.0 int/mi	Weaving lane changes, LC_W	1898 lc/h
Minimum RF lane changes, LC_{RF}	1 lc/pc	Non-weaving lane changes, LC_{NW}	982 lc/h
Minimum FR lane changes, LC_{FR}	1 lc/pc	Total lane changes, LC_{ALL}	2880 lc/h
Minimum RR lane changes, LC_{RR}	lc/pc	Non-weaving vehicle index, I_{NW}	519

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment flow rate, v	4631 pc/h	Weaving intensity factor, W	0.335
Weaving segment capacity, c_w	5645 veh/h	Weaving segment speed, S	43.2 mph
Weaving segment v/c ratio	0.789	Average weaving speed, S_W	48.7 mph
Weaving segment density, D	35.7 pc/mi/ln	Average non-weaving speed, S_{NW}	40.6 mph
Level of Service, LOS	E	Maximum weaving length, L_{MAX}	6231 ft

Notes

a. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments".
b. For volumes that exceed the weaving segment capacity, the level of service is "F".

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Navy Base ICTF

FREEWAY WEAVING WORKSHEET

General Information

Analyst	AJR
Agency/Company	Atkins
Date Performed	7/25/2014
Analysis Time Period	PM Peak

Site Information

Freeway/Dir of Travel	I-526 WB
Weaving Segment Location	4260-Dorchester to Leeds
Analysis Year	2038 No Action

Project Description *Navy Base ICTF*

Inputs

Weaving configuration	One-Sided	Segment type	Freeway
Weaving number of lanes, N	3	Freeway minimum speed, S_{MIN}	15
Weaving segment length, L_S	1750ft	Freeway maximum capacity, C_{IFL}	2300
Freeway free-flow speed, FFS	60 mph	Terrain type	Level

Conversions to pc/h Under Base Conditions

	V (veh/h)	PHF	Truck (%)	RV (%)	E_T	E_R	f_{HV}	f_p	v (pc/h)
V_{FF}	2702	0.90	7	0	1.5	1.2	0.966	1.00	3107
V_{RF}	491	0.90	17	0	1.5	1.2	0.922	1.00	592
V_{FR}	287	0.90	15	0	1.5	1.2	0.930	1.00	343
V_{RR}	52	0.90	17	0	1.5	1.2	0.922	1.00	63
V_{NW}	3170							V =	4105
V_W	935								
VR	0.228								

Configuration Characteristics

Minimum maneuver lanes, N_{WL}	2 lc	Minimum weaving lane changes, LC_{MIN}	935 lc/h
Interchange density, ID	1.0 int/mi	Weaving lane changes, LC_W	1168 lc/h
Minimum RF lane changes, LC_{RF}	1 lc/pc	Non-weaving lane changes, LC_{NW}	1024 lc/h
Minimum FR lane changes, LC_{FR}	1 lc/pc	Total lane changes, LC_{ALL}	2192 lc/h
Minimum RR lane changes, LC_{RR}	lc/pc	Non-weaving vehicle index, I_{NW}	555

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment flow rate, v	4105 pc/h	Weaving intensity factor, W	0.270
Weaving segment capacity, c_w	5986 veh/h	Weaving segment speed, S	47.5 mph
Weaving segment v/c ratio	0.663	Average weaving speed, S_W	50.4 mph
Weaving segment density, D	28.8 pc/mi/ln	Average non-weaving speed, S_{NW}	46.7 mph
Level of Service, LOS	D	Maximum weaving length, L_{MAX}	4822 ft

Notes

a. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments".
b. For volumes that exceed the weaving segment capacity, the level of service is "F".

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-526 WB*
Agency or Company	*Atkins*	From/To	*4265-Leeds Off to Leeds On*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2038 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*2842*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*9*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.957*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*60.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*60.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1650*	pc/h/ln
S	*60.0*	mph
D = v_p / S	*27.5*	pc/mi/ln
LOS	*D*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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F-3493

BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-526 WB*
Agency or Company	*Atkins*	From/To	*4265-Leeds Off to Leeds On*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*PM Peak*	Analysis Year	*2038 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*3193*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*8*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.962*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*60.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*60.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1845*	pc/h/ln
S	*58.9*	mph
D = v_p / S	*31.3*	pc/mi/ln
LOS	*D*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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F-3494

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-526 WB
Agency or Company	Atkins	Junction	4270-WB On from Leeds
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2038 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Number of Lanes, N: 2	☐ Yes ☐ On
☑ No ☐ Off	Acceleration Lane Length, L_A: 825	☑ No ☐ Off
L_{up} = ft	Deceleration Lane Length L_D:	L_{down} = ft
V_u = veh/h	Freeway Volume, V_F: 2842	V_D = veh/h
	Ramp Volume, V_R: 222	
	Freeway Free-Flow Speed, S_{FF}: 60.0	
	Ramp Free-Flow Speed, S_{FR}: 45.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	2842	0.90	Level	9	0	0.957	1.00	3300
Ramp	222	0.90	Level	19	0	0.913	1.00	270
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 1.000 using Equation (Exhibit 13-6)

V_{12} = 3300 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	3570	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	3570	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = 28.0 (pc/mi/ln)

LOS = D (Exhibit 13-2)

Speed Determination

M_S = 0.385 (Exibit 13-11)

S_R= 53.1 mph (Exhibit 13-11)

S_0= N/A mph (Exhibit 13-11)

S = 53.1 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-526 WB
Agency or Company	Atkins	Junction	4270-WB On from Leeds
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2038 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Number of Lanes, N: 2	☐ Yes ☐ On
☑ No ☐ Off	Acceleration Lane Length, L_A: 825	☑ No ☐ Off
L_{up} = ft	Deceleration Lane Length L_D:	L_{down} = ft
V_u = veh/h	Freeway Volume, V_F: 3193	V_D = veh/h
	Ramp Volume, V_R: 696	
	Freeway Free-Flow Speed, S_{FF}: 60.0	
	Ramp Free-Flow Speed, S_{FR}: 45.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	3193	0.90	Level	8	0	0.962	1.00	3690
Ramp	696	0.90	Level	5	0	0.976	1.00	793
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 1.000 using Equation (Exhibit 13-6)

V_{12} = 3690 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	4483	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	4483	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = 34.9 (pc/mi/ln)

LOS = D (Exhibit 13-2)

Speed Determination

M_S = 0.592 (Exibit 13-11)

S_R= 49.3 mph (Exhibit 13-11)

S_0= N/A mph (Exhibit 13-11)

S = 49.3 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-526 WB*
Agency or Company	*Atkins*	From/To	*4280-Leeds to Paul Cantrell*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2038 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*3064*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*9*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.957*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*60.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*60.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1779*	pc/h/ln
S	*59.4*	mph
D = v_p / S	*29.9*	pc/mi/ln
LOS	*D*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-526 WB*
Agency or Company	*Atkins*	From/To	*4280-Leeds to Paul Cantrell*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*PM Peak*	Analysis Year	*2038 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*3889*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*8*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.962*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*60.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*60.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*2247*	pc/h/ln
S	*52.4*	mph
D = v_p / S	*42.9*	pc/mi/ln
LOS	*E*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-526 WB
Agency or Company	Atkins	Junction	4290-WB Off to PaulCantrell WB
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2038 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Number of Lanes, N	2	Downstream Adj Ramp	
☐ Yes	☐ On	Acceleration Lane Length, L_A		☐ Yes	☐ On
☑ No	☐ Off	Deceleration Lane Length L_D	825	☑ No	☐ Off
L_{up} =	ft	Freeway Volume, V_F	3064	L_{down} =	ft
		Ramp Volume, V_R	1278		
V_u =	veh/h	Freeway Free-Flow Speed, S_{FF}	60.0	V_D =	veh/h
		Ramp Free-Flow Speed, S_{FR}	45.0		

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	3064	0.90	Level	9	0	0.957	1.00	3558
Ramp	1278	0.90	Level	26	0	0.885	1.00	1605
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 1.000 using Equation (Exhibit 13-7)

V_{12} = 3558 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	3558	Exhibit 13-8	4600	No
$V_{FO} = V_F - V_R$	1953	Exhibit 13-8	4600	No
V_R	1605	Exhibit 13-10	2100	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	3558	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = 27.4 (pc/mi/ln)

LOS = C (Exhibit 13-2)

Speed Determination

D_s = 0.442 (Exhibit 13-12)

S_R= 52.0 mph (Exhibit 13-12)

S_0= N/A mph (Exhibit 13-12)

S = 52.0 mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-526 WB
Agency or Company	Atkins	Junction	4290-WB Off to PaulCantrell WB
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2038 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Number of Lanes, N	2	Downstream Adj Ramp	
☐ Yes	☐ On	Acceleration Lane Length, L_A		☐ Yes	☐ On
☑ No	☐ Off	Deceleration Lane Length L_D	825	☑ No	☐ Off
L_{up} =	ft	Freeway Volume, V_F	3889	L_{down} =	ft
V_u =	veh/h	Ramp Volume, V_R	2051	V_D =	veh/h
		Freeway Free-Flow Speed, S_{FF}	60.0		
		Ramp Free-Flow Speed, S_{FR}	45.0		

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	3889	0.90	Level	8	0	0.962	1.00	4494
Ramp	2051	0.90	Level	14	0	0.935	1.00	2438
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 1.000 using Equation (Exhibit 13-7)

V_{12} = 4494 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	4494	Exhibit 13-8	4600	No
$V_{FO} = V_F - V_R$	2056	Exhibit 13-8	4600	No
V_R	2438	Exhibit 13-10	2100	Yes

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	4494	Exhibit 13-8	4400:All	Yes

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = 35.5 (pc/mi/ln)

LOS = F (Exhibit 13-2)

Speed Determination

D_s = 0.517 (Exhibit 13-12)

S_R= 50.7 mph (Exhibit 13-12)

S_0= N/A mph (Exhibit 13-12)

S = 50.7 mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-526 WB
Agency or Company	Atkins	Junction	4300-WB Off to PaulCantrell EB
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2038 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Freeway Number of Lanes, N: 2	☐ Yes ☐ On
☑ No ☐ Off	Ramp Number of Lanes, N: 1	☑ No ☐ Off
L_{up} = ft	Acceleration Lane Length, L_A	L_{down} = ft
V_u = veh/h	Deceleration Lane Length L_D: 525	V_D = veh/h
	Freeway Volume, V_F: 1786	
	Ramp Volume, V_R: 724	
	Freeway Free-Flow Speed, S_{FF}: 60.0	
	Ramp Free-Flow Speed, S_{FR}: 25.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	1786	0.90	Level	9	0	0.957	1.00	2074
Ramp	724	0.90	Level	5	0	0.976	1.00	825
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 1.000 using Equation (Exhibit 13-7)

V_{12} = 2074 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	2074	Exhibit 13-8	4600	No
$V_{FO} = V_F - V_R$	1249	Exhibit 13-8	4600	No
V_R	825	Exhibit 13-10	1900	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	2074	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = 17.4 (pc/mi/ln)

LOS = B (Exhibit 13-2)

Speed Determination

D_s = 0.632 (Exhibit 13-12)

S_R= 48.6 mph (Exhibit 13-12)

S_0= N/A mph (Exhibit 13-12)

S = 48.6 mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-526 WB
Agency or Company	Atkins	Junction	4300-WB Off to PaulCantrell EB
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2038 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Number of Lanes, N	2	Downstream Adj Ramp	
☐ Yes	☐ On	Acceleration Lane Length, L_A		☐ Yes	☐ On
☑ No	☐ Off	Deceleration Lane Length L_D	525	☑ No	☐ Off
L_{up} =	ft	Freeway Volume, V_F	1838	L_{down} =	ft
V_u =	veh/h	Ramp Volume, V_R	771	V_D =	veh/h
		Freeway Free-Flow Speed, S_{FF}	60.0		
		Ramp Free-Flow Speed, S_{FR}	25.0		

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	1838	0.90	Level	8	0	0.962	1.00	2124
Ramp	771	0.90	Level	4	0	0.980	1.00	874
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 1.000 using Equation (Exhibit 13-7)

V_{12} = 2124 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	2124	Exhibit 13-8	4600	No
$V_{FO} = V_F - V_R$	1250	Exhibit 13-8	4600	No
V_R	874	Exhibit 13-10	1900	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	2124	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = 17.8 (pc/mi/ln)

LOS = B (Exhibit 13-2)

Speed Determination

D_s = 0.637 (Exhibit 13-12)

S_R= 48.5 mph (Exhibit 13-12)

S_0= N/A mph (Exhibit 13-12)

S = 48.5 mph (Exhibit 13-13)

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-526 WB*
Agency or Company	*Atkins*	From/To	*4305-PaulCEB Off to PaulCEB On*
Date Performed	*4/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2038 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*1062*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*9*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.957*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*60.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*60.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*617*	pc/h/ln
S	*60.0*	mph
D = v_p / S	*10.3*	pc/mi/ln
LOS	*A*	

Design (N)

Design (N)

Design LOS	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h/ln
S	mph
D = v_p / S	pc/mi/ln
Required Number of Lanes, N	

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-526 WB*
Agency or Company	*Atkins*	From/To	*4305-PaulCEB Off to PaulCEB On*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*PM Peak*	Analysis Year	*2038 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*1067*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*8*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.962*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*60.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*60.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*616*	pc/h/ln
S	*60.0*	mph
D = v_p / S	*10.3*	pc/mi/ln
LOS	*A*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-526 WB
Agency or Company	Atkins	Junction	4310-WB On from PaulCantrellEB
Date Performed	4/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2038 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Number of Lanes, N: 2	☐ Yes ☐ On
☑ No ☐ Off	Acceleration Lane Length, L_A: 700	☑ No ☐ Off
L_{up} = ft	Deceleration Lane Length L_D:	L_{down} = ft
V_u = veh/h	Freeway Volume, V_F: 1062	V_D = veh/h
	Ramp Volume, V_R: 335	
	Freeway Free-Flow Speed, S_{FF}: 60.0	
	Ramp Free-Flow Speed, S_{FR}: 45.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	1062	0.90	Level	9	0	0.957	1.00	1233
Ramp	335	0.90	Level	7	0	0.966	1.00	385
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 1.000 using Equation (Exhibit 13-6)

V_{12} = 1233 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	1618	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	1618	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = 13.5 (pc/mi/ln)

LOS = B (Exhibit 13-2)

Speed Determination

M_S = 0.278 (Exibit 13-11)

S_R= 55.0 mph (Exhibit 13-11)

S_0= N/A mph (Exhibit 13-11)

S = 55.0 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-526 WB
Agency or Company	Atkins	Junction	4310-WB On from PaulCantrellEB
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2038 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Number of Lanes, N: 2	☐ Yes ☐ On
☑ No ☐ Off	Acceleration Lane Length, L_A: 700	☑ No ☐ Off
L_{up} = ft	Deceleration Lane Length L_D:	L_{down} = ft
V_u = veh/h	Freeway Volume, V_F: 1067	V_D = veh/h
	Ramp Volume, V_R: 269	
	Freeway Free-Flow Speed, S_{FF}: 60.0	
	Ramp Free-Flow Speed, S_{FR}: 45.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	1067	0.90	Level	8	0	0.962	1.00	1233
Ramp	269	0.90	Level	7	0	0.966	1.00	309
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 1.000 using Equation (Exhibit 13-6)

V_{12} = 1233 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	1542	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	1542	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = 13.0 (pc/mi/ln)

LOS = B (Exhibit 13-2)

Speed Determination

M_S = 0.276 (Exibit 13-11)

S_R= 55.0 mph (Exhibit 13-11)

S_0= N/A mph (Exhibit 13-11)

S = 55.0 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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Appendix E
Traffic Analysis Worksheets

2038 Design Year

No Action Alternative

US Highway 17

MAJOR MERGE SEGMENTS ANALYSIS

ATKINS

General Information

Date Performed:	7/25/2014	Freeway/Direction	US 17 NB
Analysis Year	2038 No Action	Junction	From I-26 EB & WB
Analysis Time Period:	AM Peak	Segment ID	5010
Project Description:	Navy Base ICTF		

Inputs

	Freeway Upstream of On-Ramp	Freeway Downstream of On-Ramp	On-Ramp
Number of Lanes, N	2	4	2
Free-Flow Speed, FFS (mph)	55	55	55
Volume, V (veh/h)	2,036	3,489	1,453
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	4%	3%	4%
%RVs, P_R	0%	0%	0%

Performance Measures

	Freeway Upstream of On-Ramp	Freeway Downstream of On-Ramp	On-Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.98	0.99	0.98
Demand Flow Rate, v_p (pc/h/ln)	1,154	984	823
Capacity Flow Rate, c (pc/h/ln)	2,250	2,250	2,200
v/c ratio	0.51	0.44	0.37
	Below Capacity	Below Capacity	Below Capacity

Formulas and Reference Material

$$f_{HV} = \frac{1}{1 + P_T(E_T-1)+P_R(E_R-1)}$$ HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P}$$ HCM 2010, Equation 11-2

Basic Freeway Segments Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
75	2,400
70	2,400
65	2,350
60	2,300
55	2,250

Source: HCM 2010, Exhibit 11-17

Ramp Roadways Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

MAJOR MERGE SEGMENTS ANALYSIS

ATKINS

General Information

Date Performed:	7/25/2014	Freeway/Direction	US 17 NB
Analysis Year	2038 No Action	Junction	From I-26 EB & WB
Analysis Time Period:	PM Peak	Segment ID	5010
Project Description:	Navy Base ICTF		

Inputs

	Freeway Upstream of On-Ramp	Freeway Downstream of On-Ramp	On-Ramp
Number of Lanes, N	2	4	2
Free-Flow Speed, FFS (mph)	55	55	55
Volume, V (veh/h)	2,315	3,067	752
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	3%	3%	7%
%RVs, P_R	0%	0%	0%

Performance Measures

	Freeway Upstream of On-Ramp	Freeway Downstream of On-Ramp	On-Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.99	0.99	0.97
Demand Flow Rate, v_p (pc/h/ln)	1,305	865	432
Capacity Flow Rate, c (pc/h/ln)	2,250	2,250	2,200
v/c ratio	0.58	0.38	0.20
	Below Capacity	Below Capacity	Below Capacity

Formulas and Reference Material

$$f_{HV} = \frac{1}{1 + P_T(E_T-1)+P_R(E_R-1)}$$ HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P}$$ HCM 2010, Equation 11-2

Basic Freeway Segments Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
75	2,400
70	2,400
65	2,350
60	2,300
55	2,250

Source: HCM 2010, Exhibit 11-17

Ramp Roadways Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	US-17 NB
Agency or Company	Atkins	Junction	5020-NB On from Meeting
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2038 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Number of Lanes, N: 4	☐ Yes ☐ On
☑ No ☐ Off	Acceleration Lane Length, L_A: 1125	☑ No ☐ Off
L_{up} = ft	Deceleration Lane Length L_D:	L_{down} = ft
V_u = veh/h	Freeway Volume, V_F: 3489	V_D = veh/h
	Ramp Volume, V_R: 516	
	Freeway Free-Flow Speed, S_{FF}: 55.0	
	Ramp Free-Flow Speed, S_{FR}: 45.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	3489	0.90	Level	3	0	0.985	1.00	3935
Ramp	516	0.90	Level	10	0	0.952	1.00	602
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 0.143 using Equation (Exhibit 13-6)

V_{12} = 561 pc/h

V_3 or V_{av34} 1687 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * $V_{12}/2$ ☑ Yes ☐ No

If Yes, V_{12a} = 1574 pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	4537	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	2176	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = 15.1 (pc/mi/ln)

LOS = B (Exhibit 13-2)

Speed Determination

M_S = 0.254 (Exibit 13-11)

S_R= 51.7 mph (Exhibit 13-11)

S_0= 52.6 mph (Exhibit 13-11)

S = 52.1 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * $V_{12}/2$ ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	US-17 NB
Agency or Company	Atkins	Junction	5020-NB On from Meeting
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2038 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Number of Lanes, N: 4	☐ Yes ☐ On
☑ No ☐ Off	Acceleration Lane Length, L_A: 1125	☑ No ☐ Off
L_{up} = ft	Deceleration Lane Length L_D:	L_{down} = ft
V_u = veh/h	Freeway Volume, V_F: 3067	V_D = veh/h
	Ramp Volume, V_R: 928	
	Freeway Free-Flow Speed, S_{FF}: 55.0	
	Ramp Free-Flow Speed, S_{FR}: 45.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	3067	0.90	Level	3	0	0.985	1.00	3459
Ramp	928	0.90	Level	5	0	0.976	1.00	1057
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 0.086 using Equation (Exhibit 13-6)

V_{12} = 296 pc/h

V_3 or V_{av34} 1581 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * $V_{12}/2$ ☑ Yes ☐ No

If Yes, V_{12a} = 1383 pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	4516	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	2440	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = 17.0 (pc/mi/ln)

LOS = B (Exhibit 13-2)

Speed Determination

M_S = 0.264 (Exibit 13-11)

S_R= 51.6 mph (Exhibit 13-11)

S_0= 53.1 mph (Exhibit 13-11)

S = 52.2 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * $V_{12}/2$ ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	US-17 NB
Agency or Company	Atkins	Junction	5030-NB On from E Bay
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2038 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Number of Lanes, N: 4	☐ Yes ☐ On
☑ No ☐ Off	Acceleration Lane Length, L_A: 925	☑ No ☐ Off
L_{up} = ft	Deceleration Lane Length L_D:	L_{down} = ft
V_u = veh/h	Freeway Volume, V_F: 4005	V_D = veh/h
	Ramp Volume, V_R: 346	
	Freeway Free-Flow Speed, S_{FF}: 55.0	
	Ramp Free-Flow Speed, S_{FR}: 45.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	4005	0.90	Level	5	0	0.976	1.00	4561
Ramp	346	0.90	Level	15	0	0.930	1.00	413
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 0.166 using Equation (Exhibit 13-6)

V_{12} = 758 pc/h

V_3 or V_{av34} 1901 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * $V_{12}/2$ ☑ Yes ☐ No

If Yes, V_{12a} = 1824 pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	4974	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	2237	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = 16.9 (pc/mi/ln)

LOS = B (Exhibit 13-2)

Speed Determination

M_S = 0.274 (Exibit 13-11)

S_R= 51.4 mph (Exhibit 13-11)

S_0= 51.9 mph (Exhibit 13-11)

S = 51.7 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * $V_{12}/2$ ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	US-17 NB
Agency or Company	Atkins	Junction	5030-NB On from E Bay
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2038 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Number of Lanes, N: 4	☐ Yes ☐ On
☑ No ☐ Off	Acceleration Lane Length, L_A: 925	☑ No ☐ Off
L_{up} = ft	Deceleration Lane Length L_D:	L_{down} = ft
V_u = veh/h	Freeway Volume, V_F: 3995	V_D = veh/h
	Ramp Volume, V_R: 1210	
	Freeway Free-Flow Speed, S_{FF}: 55.0	
	Ramp Free-Flow Speed, S_{FR}: 45.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	3995	0.90	Level	4	0	0.980	1.00	4528
Ramp	1210	0.90	Level	4	0	0.980	1.00	1371
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 0.046 using Equation (Exhibit 13-6)

V_{12} = 210 pc/h

V_3 or V_{av34} 2159 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * $V_{12}/2$ ☑ Yes ☐ No

If Yes, V_{12a} = 1811 pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	5899	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	3182	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = 23.9 (pc/mi/ln)

LOS = C (Exhibit 13-2)

Speed Determination

M_S = 0.332 (Exibit 13-11)

S_R= 50.7 mph (Exhibit 13-11)

S_0= 51.9 mph (Exhibit 13-11)

S = 51.2 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * $V_{12}/2$ ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*US-17 NB*
Agency or Company	*Atkins*	From/To	*5040-E Bay to SC-703*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2038 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*4351*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*5*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.976*

Speed Inputs			Calc Speed Adj and FFS		
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f_{LW}		mph
Number of Lanes, N	*4*		f_{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	*55.0*	mph	FFS	*55.0*	mph
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures			Design (N)	
Operational (LOS)			Design (N)	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1239*	pc/h/ln	Design LOS	
			v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h/ln
S	*55.0*	mph	S	mph
D = v_p / S	*22.5*	pc/mi/ln	D = v_p / S	pc/mi/ln
LOS	*C*		Required Number of Lanes, N	

Glossary		Factor Location	
N - Number of lanes	S - Speed	E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
V - Hourly volume	D - Density	E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 11-18	TRD - Page 11-11
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 11-2, 11-3	
DDHV - Directional design hour volume			

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*US-17 NB*
Agency or Company	*Atkins*	From/To	*5040-E Bay to SC-703*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*PM Peak*	Analysis Year	*2038 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*5205*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*4*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.980*

Speed Inputs			Calc Speed Adj and FFS		
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f_{LW}		mph
Number of Lanes, N	*4*		f_{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	*55.0*	mph	FFS	*55.0*	mph
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures			Design (N)	
Operational (LOS)			Design (N)	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1475*	pc/h/ln	Design LOS	
			v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h/ln
S	*55.0*	mph	S	mph
D = v_p / S	*26.8*	pc/mi/ln	D = v_p / S	pc/mi/ln
LOS	*D*		Required Number of Lanes, N	

Glossary		Factor Location	
N - Number of lanes	S - Speed	E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
V - Hourly volume	D - Density	E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 11-18	TRD - Page 11-11
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 11-2, 11-3	
DDHV - Directional design hour volume			

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MAJOR DIVERGE SEGMENTS ANALYSIS

ATKINS

General Information

Date Performed:	7/25/2014	Freeway/Direction	US-17 NB
Analysis Year	2038 No Action	Junction	Off to SC-703
Analysis Time Period:	AM Peak	Segment ID	5050
Project Description:	Navy Base ICTF		

Inputs

	Freeway Upstream of Off-Ramp	Freeway Downstream of Off-Ramp	Off-Ramp
Number of Lanes, N	4	2	2
Free-Flow Speed, FFS (mph)	55	45	40
Volume, V (veh/h)	4,351	3,191	1,160
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	5%	4%	8%
%RVs, P_R	0%	0%	0%

Performance Measures

	Upstream of Off-Ramp	Downstream of Off-Ramp	Off-Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.98	0.98	0.96
Demand Flow Rate, v_p (pc/h/ln)	1,239	1,808	670
Capacity Flow Rate, c (pc/h/ln)	2,200	2,100	2,000
v/c ratio	0.56	0.86	0.34
Density, D_{MD} (pc/mi/ln)	21.7	31.6	11.7
LOS	C	D	B

Formulas and Reference Material

$$f_{HV} = \frac{1}{1 + P_T(E_T-1)+P_R(E_R-1)}$$ HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P}$$ HCM 2010, Equation 11-2

$$D_{MD} = \frac{0.0175*v_f}{N}$$ HCM 2010, Equation 13-26

Ramp Roadways Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

Diverge LOS Thresholds

LOS	Density (pc/mi/ln)
A	≤10
B	>10-20
C	>20-28
D	>28-35
E	>35
F	v/c > 1

Source: HCM 2010, Exhibit 13-2

MAJOR DIVERGE SEGMENTS ANALYSIS

ATKINS

General Information

Date Performed:	7/25/2014	Freeway/Direction	US-17 NB
Analysis Year	2038 No Action	Junction	Off to SC-703
Analysis Time Period:	PM Peak	Segment ID	5050
Project Description:	Navy Base ICTF		

Inputs

	Freeway Upstream of Off-Ramp	Freeway Downstream of Off-Ramp	Off-Ramp
Number of Lanes, N	4	2	2
Free-Flow Speed, FFS (mph)	55	45	40
Volume, V (veh/h)	5,205	3,568	1,637
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	4%	3%	5%
%RVs, P_R	0%	0%	0%

Performance Measures

	Upstream of Off-Ramp	Downstream of Off-Ramp	Off-Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.98	0.99	0.98
Demand Flow Rate, v_p (pc/h/ln)	1,475	2,012	932
Capacity Flow Rate, c (pc/h/ln)	2,200	2,100	2,000
v/c ratio	0.67	0.96	0.47
Density, D_{MD} (pc/mi/ln)	25.8	35.2	16.3
LOS	C	E	B

Formulas and Reference Material

$$f_{HV} = \frac{1}{1+P_T(E_T-1)+P_R(E_R-1)}$$ HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P}$$ HCM 2010, Equation 11-2

$$D_{MD} = \frac{0.0175*v_f}{N}$$ HCM 2010, Equation 13-26

Ramp Roadways Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

Diverge LOS Thresholds

LOS	Density (pc/mi/ln)
A	≤10
B	>10-20
C	>20-28
D	>28-35
E	>35
F	v/c > 1

Source: HCM 2010, Exhibit 13-2

RAMP ADD OR DROP LANE ANALYSIS (MAINLINE <55 MPH)

ATKINS

General Information

Date Performed:	7/25/2014	Freeway/Direction	US-17 NB
Analysis Year	2038 No Action	Junction	Off to Bowman
Analysis Time Period:	AM Peak	Segment ID	5060
Project Description:	Navy Base ICTF		

Inputs

	Mainline Upstream Ramp	Mainline Downstream Ramp	Ramp
Number of Lanes, N	3	2	1
Free-Flow Speed, FFS (mph)	45	45	45
Volume, V (veh/h)	2,476	1,809	667
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	5%	7%	2%
%RVs, P_R	0%	0%	0%

Performance Measures

	Upstream of Off-Ramp	Downstream of Off-Ramp	Off-Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.98	0.97	0.99
Demand Flow Rate, v_p (pc/h/ln)	940	1,040	749
Capacity Flow Rate, c (pc/h/ln)	2,100	2,100	2,100
v/c ratio	0.45	0.50	0.36
Density, D_{MD} (pc/mi/ln)	16.5	18.2	13.1
LOS	B	B	B

Formulas and Reference Material

$$f_{HV} = \frac{1}{1+P_T(E_T-1)+P_R(E_R-1)}$$ HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P}$$ HCM 2010, Equation 11-2

$$D_{MD} = \frac{0.0175*v_f}{N}$$ HCM 2010, Equation 13-26

Ramp Roadways Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

Diverge LOS Thresholds

LOS	Density (pc/mi/ln)
A	≤10
B	>10-20
C	>20-28
D	>28-35
E	>35
F	v/c > 1

Source: HCM 2010, Exhibit 13-2

RAMP ADD OR DROP LANE ANALYSIS (MAINLINE <55 MPH)

ATKINS

General Information

Date Performed:	7/25/2014	Freeway/Direction	US-17 NB
Analysis Year	2038 No Action	Junction	Off to Bowman
Analysis Time Period:	PM Peak	Segment ID	5060
Project Description:	Navy Base ICTF		

Inputs

	Mainline Upstream Ramp	Mainline Downstream Ramp	Ramp
Number of Lanes, N	3	2	1
Free-Flow Speed, FFS (mph)	45	45	45
Volume, V (veh/h)	3,406	2,708	698
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	4%	5%	2%
%RVs, P_R	0%	0%	0%

Performance Measures

	Upstream of Off-Ramp	Downstream of Off-Ramp	Off-Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.98	0.98	0.99
Demand Flow Rate, v_p (pc/h/ln)	1,287	1,542	783
Capacity Flow Rate, c (pc/h/ln)	2,100	2,100	2,100
v/c ratio	0.61	0.73	0.37
Density, D_{MD} (pc/mi/ln)	22.5	27.0	13.7
LOS	C	C	B

Formulas and Reference Material

$$f_{HV} = \frac{1}{1+P_T(E_T-1)+P_R(E_R-1)}$$ HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P}$$ HCM 2010, Equation 11-2

$$D_{MD} = \frac{0.0175*v_f}{N}$$ HCM 2010, Equation 13-26

Ramp Roadways Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

Diverge LOS Thresholds

LOS	Density (pc/mi/ln)
A	≤10
B	>10-20
C	>20-28
D	>28-35
E	>35
F	v/c > 1

Source: HCM 2010, Exhibit 13-2

BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*US-17 NB*
Agency or Company	*Atkins*	From/To	*5065-Bowman Off to Bowman On*
Date Performed	*4/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2038 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*1809*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*7*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.966*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*55.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*55.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1040*	pc/h/ln
S	*55.0*	mph
D = v_p / S	*18.9*	pc/mi/ln
LOS	*C*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*US-17 NB*
Agency or Company	*Atkins*	From/To	*5065-Bowman Off to Bowman On*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*PM Peak*	Analysis Year	*2038 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*2708*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*5*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.976*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*55.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*55.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1542*	pc/h/ln
S	*55.0*	mph
D = v_p / S	*28.0*	pc/mi/ln
LOS	*D*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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Navy Base ICTF

FREEWAY WEAVING WORKSHEET

General Information

Analyst	AJR
Agency/Company	Atkins
Date Performed	7/25/2014
Analysis Time Period	AM Peak

Site Information

Freeway/Dir of Travel	US-17 NB
Weaving Segment Location	5070-Bowman On to I-526 WB Off
Analysis Year	2038 No Action

Project Description *Navy Base ICTF*

Inputs

Weaving configuration	One-Sided
Weaving number of lanes, N	3
Weaving segment length, L_S	825ft
Freeway free-flow speed, FFS	45 mph
Segment type	C-D Roadway/ Multilane Highways
Freeway minimum speed, S_{MIN}	15
Freeway maximum capacity, C_{IFL}	2250
Terrain type	Level

Conversions to pc/h Under Base Conditions

	V (veh/h)	PHF	Truck (%)	RV (%)	E_T	E_R	f_{HV}	f_p	v (pc/h)
V_{FF}	1053	0.90	7	0	1.5	1.2	0.966	1.00	1211
V_{RF}	294	0.90	13	0	1.5	1.2	0.939	1.00	348
V_{FR}	756	0.90	8	0	1.5	1.2	0.962	1.00	874
V_{RR}	212	0.90	13	0	1.5	1.2	0.939	1.00	251
V_{NW}	1462							V =	2684
V_W	1222								
VR	0.455								

Configuration Characteristics

Minimum maneuver lanes, N_{WL}	2 lc	Minimum weaving lane changes, LC_{MIN}	1222 lc/h
Interchange density, ID	0.3 int/mi	Weaving lane changes, LC_W	1321 lc/h
Minimum RF lane changes, LC_{RF}	1 lc/pc	Non-weaving lane changes, LC_{NW}	171 lc/h
Minimum FR lane changes, LC_{FR}	1 lc/pc	Total lane changes, LC_{ALL}	1492 lc/h
Minimum RR lane changes, LC_{RR}	lc/pc	Non-weaving vehicle index, I_{NW}	36

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment flow rate, v	2684 pc/h	Weaving intensity factor, W	0.361
Weaving segment capacity, c_w	5084 veh/h	Weaving segment speed, S	34.1 mph
Weaving segment v/c ratio	0.510	Average weaving speed, S_W	37.0 mph
Weaving segment density, D	26.3 pc/mi/ln	Average non-weaving speed, S_{NW}	31.9 mph
Level of Service, LOS	C	Maximum weaving length, L_{MAX}	7309 ft

Notes

a. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments".
b. For volumes that exceed the weaving segment capacity, the level of service is "F".

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Navy Base ICTF

FREEWAY WEAVING WORKSHEET

General Information

Analyst	AJR
Agency/Company	Atkins
Date Performed	7/25/2014
Analysis Time Period	PM Peak

Site Information

Freeway/Dir of Travel	US-17 NB
Weaving Segment Location	5070-Bowman On to I-526 WB Off
Analysis Year	2038 No Action

Project Description *Navy Base ICTF*

Inputs

Weaving configuration	One-Sided
Weaving number of lanes, N	3
Weaving segment length, L_S	825ft
Freeway free-flow speed, FFS	45 mph
Segment type	C-D Roadway/ Multilane Highways
Freeway minimum speed, S_{MIN}	15
Freeway maximum capacity, C_{IFL}	2250
Terrain type	Level

Conversions to pc/h Under Base Conditions

	V (veh/h)	PHF	Truck (%)	RV (%)	E_T	E_R	f_{HV}	f_p	v (pc/h)
V_{FF}	1998	0.90	5	0	1.5	1.2	0.976	1.00	2276
V_{RF}	662	0.90	6	0	1.5	1.2	0.971	1.00	758
V_{FR}	710	0.90	7	0	1.5	1.2	0.966	1.00	817
V_{RR}	236	0.90	7	0	1.5	1.2	0.966	1.00	271
V_{NW}	2547							V =	4122
V_W	1575								
VR	0.382								

Configuration Characteristics

Minimum maneuver lanes, N_{WL}	2 lc
Interchange density, ID	0.3 int/mi
Minimum RF lane changes, LC_{RF}	1 lc/pc
Minimum FR lane changes, LC_{FR}	1 lc/pc
Minimum RR lane changes, LC_{RR}	lc/pc
Minimum weaving lane changes, LC_{MIN}	1575 lc/h
Weaving lane changes, LC_W	1674 lc/h
Non-weaving lane changes, LC_{NW}	394 lc/h
Total lane changes, LC_{ALL}	2068 lc/h
Non-weaving vehicle index, I_{NW}	63

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment flow rate, v	4122 pc/h
Weaving segment capacity, c_w	5318 veh/h
Weaving segment v/c ratio	0.756
Weaving segment density, D	46.2 pc/mi/ln
Level of Service, LOS	E
Weaving intensity factor, W	0.467
Weaving segment speed, S	29.8 mph
Average weaving speed, S_W	35.5 mph
Average non-weaving speed, S_{NW}	27.1 mph
Maximum weaving length, L_{MAX}	6481 ft

Notes

a. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments".
b. For volumes that exceed the weaving segment capacity, the level of service is "F".

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*US-17 NB*
Agency or Company	*Atkins*	From/To	*5075-526 WB Off to 526 WB On*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2038 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*1347*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*7*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.966*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*55.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*55.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*775*	pc/h/ln
S	*55.0*	mph
D = v_p / S	*14.1*	pc/mi/ln
LOS	*B*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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F-3524

BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*US-17 NB*
Agency or Company	*Atkins*	From/To	*5075-526 WB Off to 526 WB On*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*PM Peak*	Analysis Year	*2038 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*2660*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*5*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.976*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*55.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*55.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1515*	pc/h/ln
S	*55.0*	mph
D = v_p / S	*27.5*	pc/mi/ln
LOS	*D*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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RAMP ADD OR DROP LANE ANALYSIS (MAINLINE <55 MPH)

ATKINS

General Information

Date Performed:	7/25/2014	Freeway/Direction	US 17 NB
Analysis Year	2038 No Action	Junction	From I-526 WB
Analysis Time Period:	AM Peak	Segment ID	5080
Project Description:	Navy Base ICTF		

Inputs

	Mainline Upstream Ramp	Mainline Downstream Ramp	Ramp
Number of Lanes, N	2	3	1
Free-Flow Speed, FFS (mph)	45	45	45
Volume, V (veh/h)	1,347	1,680	333
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	7%	7%	12%
%RVs, P_R	0%	0%	0%

Performance Measures

	Upstream of Off-Ramp	Downstream of Off-Ramp	Off-Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.97	0.97	0.94
Demand Flow Rate, v_p (pc/h/ln)	775	644	392
Capacity Flow Rate, c (pc/h/ln)	2,100	2,100	2,100
v/c ratio	0.37	0.31	0.19
Density, D_{MD} (pc/mi/ln)	13.6	11.3	6.9
LOS	B	B	A

Formulas and Reference Material

$$f_{HV} = \frac{1}{1+P_T(E_T-1)+P_R(E_R-1)}$$ HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P}$$ HCM 2010, Equation 11-2

$$D_{MD} = \frac{0.0175*v_f}{N}$$ HCM 2010, Equation 13-26

Ramp Roadways Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

Diverge LOS Thresholds

LOS	Density (pc/mi/ln)
A	≤10
B	>10-20
C	>20-28
D	>28-35
E	>35
F	v/c > 1

Source: HCM 2010, Exhibit 13-2

RAMP ADD OR DROP LANE ANALYSIS (MAINLINE <55 MPH)

ATKINS

General Information

Date Performed:	7/25/2014	Freeway/Direction	US 17 NB
Analysis Year	2038 No Action	Junction	From I-526 WB
Analysis Time Period:	PM Peak	Segment ID	5080
Project Description:	Navy Base ICTF		

Inputs

	Mainline Upstream Ramp	Mainline Downstream Ramp	Ramp
Number of Lanes, N	2	3	1
Free-Flow Speed, FFS (mph)	45	45	45
Volume, V (veh/h)	2,660	3,137	477
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	5%	5%	7%
%RVs, P_R	0%	0%	0%

Performance Measures

	Upstream of Off-Ramp	Downstream of Off-Ramp	Off-Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.98	0.98	0.97
Demand Flow Rate, v_p (pc/h/ln)	1,515	1,191	549
Capacity Flow Rate, c (pc/h/ln)	2,100	2,100	2,100
v/c ratio	0.72	0.57	0.26
Density, D_{MD} (pc/mi/ln)	26.5	20.8	9.6
LOS	C	C	A

Formulas and Reference Material

$$f_{HV} = \frac{1}{1+P_T(E_T-1)+P_R(E_R-1)}$$ HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P}$$ HCM 2010, Equation 11-2

$$D_{MD} = \frac{0.0175*v_f}{N}$$ HCM 2010, Equation 13-26

Ramp Roadways Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

Diverge LOS Thresholds

LOS	Density (pc/mi/ln)
A	≤10
B	>10-20
C	>20-28
D	>28-35
E	>35
F	v/c > 1

Source: HCM 2010, Exhibit 13-2

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	US-17 SB
Agency or Company	Atkins	Junction	6010-Off to I-526 EB
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2038 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Number of Lanes, N	2	Downstream Adj Ramp	
☐ Yes	☐ On	Acceleration Lane Length, L_A		☐ Yes	☐ On
☑ No	☐ Off	Deceleration Lane Length L_D	450	☑ No	☐ Off
L_{up} =	ft	Freeway Volume, V_F	2573	L_{down} =	ft
V_u =	veh/h	Ramp Volume, V_R	378	V_D =	veh/h
		Freeway Free-Flow Speed, S_{FF}	55.0		
		Ramp Free-Flow Speed, S_{FR}	45.0		

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	2573	0.90	Level	7	0	0.966	1.00	2959
Ramp	378	0.90	Level	3	0	0.985	1.00	426
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 1.000 using Equation (Exhibit 13-7)

V_{12} = 2959 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	2959	Exhibit 13-8	4500	No
$V_{FO} = V_F - V_R$	2533	Exhibit 13-8	4500	No
V_R	426	Exhibit 13-10	2100	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	2959	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = 25.6 (pc/mi/ln)

LOS = C (Exhibit 13-2)

Speed Determination

D_s = 0.336 (Exhibit 13-12)

S_R= 50.6 mph (Exhibit 13-12)

S_0= N/A mph (Exhibit 13-12)

S = 50.6 mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	US-17 SB
Agency or Company	Atkins	Junction	6010-Off to I-526 EB
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2038 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Number of Lanes, N	2	Downstream Adj Ramp	
☐ Yes	☐ On	Acceleration Lane Length, L_A		☐ Yes	☐ On
☑ No	☐ Off	Deceleration Lane Length L_D	450	☑ No	☐ Off
L_{up} =	ft	Freeway Volume, V_F	2013	L_{down} =	ft
V_u =	veh/h	Ramp Volume, V_R	305	V_D =	veh/h
		Freeway Free-Flow Speed, S_{FF}	55.0		
		Ramp Free-Flow Speed, S_{FR}	45.0		

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	2013	0.90	Level	5	0	0.976	1.00	2293
Ramp	305	0.90	Level	4	0	0.980	1.00	346
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 1.000 using Equation (Exhibit 13-7)

V_{12} = 2293 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	2293	Exhibit 13-8	4500	No
$V_{FO} = V_F - V_R$	1947	Exhibit 13-8	4500	No
V_R	346	Exhibit 13-10	2100	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	2293	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = 19.9 (pc/mi/ln)

LOS = B (Exhibit 13-2)

Speed Determination

D_s = 0.329 (Exhibit 13-12)

S_R= 50.7 mph (Exhibit 13-12)

S_0= N/A mph (Exhibit 13-12)

S = 50.7 mph (Exhibit 13-13)

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*US 17 SB*
Agency or Company	*Atkins*	From/To	*6015-526 EB Off to 526 EB On*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2038 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*2195*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*7*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.966*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*55.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*55.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1262*	pc/h/ln
S	*55.0*	mph
D = v_p / S	*22.9*	pc/mi/ln
LOS	*C*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*US-17 SB*
Agency or Company	*Atkins*	From/To	*6015-526 EB Off to 526 EB On*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*PM Peak*	Analysis Year	*2038 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*1708*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*5*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.976*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*55.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*55.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*973*	pc/h/ln
S	*55.0*	mph
D = v_p / S	*17.7*	pc/mi/ln
LOS	*B*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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Navy Base ICTF

FREEWAY WEAVING WORKSHEET

General Information

Analyst	AJR
Agency/Company	Atkins
Date Performed	7/25/2014
Analysis Time Period	AM Peak

Site Information

Freeway/Dir of Travel	US-17 SB
Weaving Segment Location	6020-I-526 EB On to Bowman Off
Analysis Year	2038 No Action

Project Description *Navy Base ICTF*

Inputs

Weaving configuration	One-Sided
Weaving number of lanes, N	4
Weaving segment length, L_S	650ft
Freeway free-flow speed, FFS	45 mph
Segment type	C-D Roadway/ Multilane Highways
Freeway minimum speed, S_{MIN}	15
Freeway maximum capacity, C_{IFL}	2250
Terrain type	Level

Conversions to pc/h Under Base Conditions

	V (veh/h)	PHF	Truck (%)	RV (%)	E_T	E_R	f_{HV}	f_p	v (pc/h)
V_{FF}	1739	0.90	7	0	1.5	1.2	0.966	1.00	2000
V_{RF}	902	0.90	12	0	1.5	1.2	0.943	1.00	1062
V_{FR}	456	0.90	11	0	1.5	1.2	0.948	1.00	535
V_{RR}	237	0.90	12	0	1.5	1.2	0.943	1.00	279
V_{NW}	2279							V =	3876
V_W	1597								
VR	0.412								

Configuration Characteristics

Minimum maneuver lanes, N_{WL}	3 lc	Minimum weaving lane changes, LC_{MIN}	1062 lc/h
Interchange density, ID	0.3 int/mi	Weaving lane changes, LC_W	1206 lc/h
Minimum RF lane changes, LC_{RF}	1 lc/pc	Non-weaving lane changes, LC_{NW}	51 lc/h
Minimum FR lane changes, LC_{FR}	0 lc/pc	Total lane changes, LC_{ALL}	1257 lc/h
Minimum RR lane changes, LC_{RR}	lc/pc	Non-weaving vehicle index, I_{NW}	44

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment flow rate, v	3876 pc/h	Weaving intensity factor, W	0.380
Weaving segment capacity, c_w	7335 veh/h	Weaving segment speed, S	34.3 mph
Weaving segment v/c ratio	0.511	Average weaving speed, S_W	36.7 mph
Weaving segment density, D	28.3 pc/mi/ln	Average non-weaving speed, S_{NW}	32.7 mph
Level of Service, LOS	C	Maximum weaving length, L_{MAX}	5250 ft

Notes

a. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments".
b. For volumes that exceed the weaving segment capacity, the level of service is "F".

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Navy Base ICTF

FREEWAY WEAVING WORKSHEET

General Information

Analyst	AJR
Agency/Company	Atkins
Date Performed	7/25/2014
Analysis Time Period	PM Peak

Site Information

Freeway/Dir of Travel	US-17 SB
Weaving Segment Location	6020-I-526 EB On to Bowman Off
Analysis Year	2038 No Action

Project Description *Navy Base ICTF*

Inputs

Weaving configuration	One-Sided
Weaving number of lanes, N	4
Weaving segment length, L_S	650ft
Freeway free-flow speed, FFS	45 mph
Segment type	C-D Roadway/ Multilane Highways
Freeway minimum speed, S_{MIN}	15
Freeway maximum capacity, C_{IFL}	2250
Terrain type	Level

Conversions to pc/h Under Base Conditions

	V (veh/h)	PHF	Truck (%)	RV (%)	E_T	E_R	f_{HV}	f_p	v (pc/h)
V_{FF}	1269	0.90	5	0	1.5	1.2	0.976	1.00	1445
V_{RF}	829	0.90	11	0	1.5	1.2	0.948	1.00	972
V_{FR}	439	0.90	9	0	1.5	1.2	0.957	1.00	510
V_{RR}	287	0.90	11	0	1.5	1.2	0.948	1.00	336
V_{NW}	1781							V =	3263
V_W	1482								
VR	0.454								

Configuration Characteristics

Minimum maneuver lanes, N_{WL}	3 lc	Minimum weaving lane changes, LC_{MIN}	972 lc/h
Interchange density, ID	0.3 int/mi	Weaving lane changes, LC_W	1116 lc/h
Minimum RF lane changes, LC_{RF}	1 lc/pc	Non-weaving lane changes, LC_{NW}	0 lc/h
Minimum FR lane changes, LC_{FR}	0 lc/pc	Total lane changes, LC_{ALL}	1116 lc/h
Minimum RR lane changes, LC_{RR}	lc/pc	Non-weaving vehicle index, I_{NW}	35

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment flow rate, v	3263 pc/h	Weaving intensity factor, W	0.346
Weaving segment capacity, c_w	7262 veh/h	Weaving segment speed, S	35.5 mph
Weaving segment v/c ratio	0.438	Average weaving speed, S_W	37.3 mph
Weaving segment density, D	23.0 pc/mi/ln	Average non-weaving speed, S_{NW}	34.1 mph
Level of Service, LOS	B	Maximum weaving length, L_{MAX}	5730 ft

Notes

a. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments".
b. For volumes that exceed the weaving segment capacity, the level of service is "F".

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*US-17 SB*
Agency or Company	*Atkins*	From/To	*6025-Bowman Off to Bowman On*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2038 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*2641*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*7*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.966*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*55.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*55.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1519*	pc/h/ln
S	*55.0*	mph
D = v_p / S	*27.6*	pc/mi/ln
LOS	*D*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*US-17 SB*
Agency or Company	*Atkins*	From/To	*6025-Bowman Off to Bowman On*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*PM Peak*	Analysis Year	*2038 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*2098*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*5*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.976*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*55.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*55.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1195*	pc/h/ln
S	*55.0*	mph
D = v_p / S	*21.7*	pc/mi/ln
LOS	*C*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	US-17 SB
Agency or Company	Atkins	Junction	6030-SB On from Bowman
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2038 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Number of Lanes, N: 2	☐ Yes ☐ On
☑ No ☐ Off	Acceleration Lane Length, L_A: 900	☑ No ☐ Off
L_{up} = ft	Deceleration Lane Length L_D:	L_{down} = ft
V_u = veh/h	Freeway Volume, V_F: 2641	V_D = veh/h
	Ramp Volume, V_R: 739	
	Freeway Free-Flow Speed, S_{FF}: 55.0	
	Ramp Free-Flow Speed, S_{FR}: 45.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	2641	0.90	Level	7	0	0.966	1.00	3037
Ramp	739	0.90	Level	2	0	0.990	1.00	829
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 1.000 using Equation (Exhibit 13-6)

V_{12} = 3037 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	3866	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	3866	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = 29.6 (pc/mi/ln)

LOS = D (Exhibit 13-2)

Speed Determination

M_S = 0.426 (Exibit 13-11)

S_R= 49.5 mph (Exhibit 13-11)

S_0= N/A mph (Exhibit 13-11)

S = 49.5 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	US-17 SB
Agency or Company	Atkins	Junction	6030-SB On from Bowman
Date Performed	4/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2038 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Number of Lanes, N: 2	☐ Yes ☐ On
☑ No ☐ Off	Acceleration Lane Length, L_A: 900	☑ No ☐ Off
L_{up} = ft	Deceleration Lane Length L_D:	L_{down} = ft
V_u = veh/h	Freeway Volume, V_F: 2098	V_D = veh/h
	Ramp Volume, V_R: 753	
	Freeway Free-Flow Speed, S_{FF}: 55.0	
	Ramp Free-Flow Speed, S_{FR}: 45.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	2098	0.90	Level	5	0	0.976	1.00	2389
Ramp	753	0.90	Level	2	0	0.990	1.00	845
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 1.000 using Equation (Exhibit 13-6)

V_{12} = 2389 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	3234	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	3234	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = 24.7 (pc/mi/ln)

LOS = C (Exhibit 13-2)

Speed Determination

M_S = 0.339 (Exibit 13-11)

S_R= 50.6 mph (Exhibit 13-11)

S_0= N/A mph (Exhibit 13-11)

S = 50.6 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	US-17 SB
Agency or Company	Atkins	Junction	6035-SB On from Wingo Way
Date Performed	4/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2038 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Number of Lanes, N: 2	☐ Yes ☐ On
☑ No ☐ Off	Acceleration Lane Length, L_A: 875	☑ No ☐ Off
L_{up} = ft	Deceleration Lane Length L_D:	L_{down} = ft
V_u = veh/h	Freeway Volume, V_F: 2577	V_D = veh/h
	Ramp Volume, V_R: 873	
	Freeway Free-Flow Speed, S_{FF}: 55.0	
	Ramp Free-Flow Speed, S_{FR}: 45.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	2577	0.90	Level	4	0	0.980	1.00	2921
Ramp	873	0.90	Level	3	0	0.985	1.00	985
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 1.000 using Equation (Exhibit 13-6)

V_{12} = 2921 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	3906	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	3906	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = 30.0 (pc/mi/ln)

LOS = D (Exhibit 13-2)

Speed Determination

M_S = 0.436 (Exibit 13-11)

S_R= 49.3 mph (Exhibit 13-11)

S_0= N/A mph (Exhibit 13-11)

S = 49.3 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	US-17 SB
Agency or Company	Atkins	Junction	6035-SB On from Wingo Way
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2038 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Number of Lanes, N: 2	☐ Yes ☐ On
☑ No ☐ Off	Acceleration Lane Length, L_A: 875	☑ No ☐ Off
L_{up} = ft	Deceleration Lane Length L_D:	L_{down} = ft
V_u = veh/h	Freeway Volume, V_F: 2517	V_D = veh/h
	Ramp Volume, V_R: 890	
	Freeway Free-Flow Speed, S_{FF}: 55.0	
	Ramp Free-Flow Speed, S_{FR}: 45.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	2517	0.90	Level	4	0	0.980	1.00	2853
Ramp	890	0.90	Level	2	0	0.990	1.00	999
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 1.000 using Equation (Exhibit 13-6)

V_{12} = 2853 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	3852	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	3852	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = 29.6 (pc/mi/ln)

LOS = D (Exhibit 13-2)

Speed Determination

M_S = 0.426 (Exibit 13-11)

S_R= 49.5 mph (Exhibit 13-11)

S_0= N/A mph (Exhibit 13-11)

S = 49.5 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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MAJOR MERGE SEGMENTS ANALYSIS

ATKINS

General Information

Date Performed:	7/25/2014	Freeway/Direction	US 17 SB
Analysis Year	2038 No Action	Junction	From SC-703
Analysis Time Period:	AM Peak	Segment ID	6040
Project Description:	Navy Base ICTF		

Inputs

	Freeway Upstream of On-Ramp	Freeway Downstream of On-Ramp	On-Ramp
Number of Lanes, N	2	4	2
Free-Flow Speed, FFS (mph)	55	55	40
Volume, V (veh/h)	3,450	4,910	1,460
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	4%	5%	7%
%RVs, P_R	0%	0%	0%

Performance Measures

	Freeway Upstream of On-Ramp	Freeway Downstream of On-Ramp	On-Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.98	0.98	0.97
Demand Flow Rate, v_p (pc/h/ln)	1,955	1,398	840
Capacity Flow Rate, c (pc/h/ln)	2,250	2,250	2,000
v/c ratio	0.87	0.62	0.42
	Below Capacity	Below Capacity	Below Capacity

Formulas and Reference Material

$$f_{HV} = \frac{1}{1 + P_T(E_T-1)+P_R(E_R-1)}$$ HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P}$$ HCM 2010, Equation 11-2

Basic Freeway Segments Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
75	2,400
70	2,400
65	2,350
60	2,300
55	2,250

Source: HCM 2010, Exhibit 11-17

Ramp Roadways Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

MAJOR MERGE SEGMENTS ANALYSIS

ATKINS

General Information

Date Performed:	7/25/2014	Freeway/Direction	US 17 SB
Analysis Year	2038 No Action	Junction	From SC-703
Analysis Time Period:	PM Peak	Segment ID	6040
Project Description:	Navy Base ICTF		

Inputs

	Freeway Upstream of On-Ramp	Freeway Downstream of On-Ramp	On-Ramp
Number of Lanes, N	2	4	2
Free-Flow Speed, FFS (mph)	55	55	40
Volume, V (veh/h)	3,407	4,709	1,302
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	3%	4%	7%
%RVs, P_R	0%	0%	0%

Performance Measures

	Freeway Upstream of On-Ramp	Freeway Downstream of On-Ramp	On-Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.99	0.98	0.97
Demand Flow Rate, v_p (pc/h/ln)	1,921	1,334	749
Capacity Flow Rate, c (pc/h/ln)	2,250	2,250	2,000
v/c ratio	0.85	0.59	0.37
	Below Capacity	Below Capacity	Below Capacity

Formulas and Reference Material

$$f_{HV} = \frac{1}{1 + P_T(E_T-1)+P_R(E_R-1)}$$ HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P}$$ HCM 2010, Equation 11-2

Basic Freeway Segments Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
75	2,400
70	2,400
65	2,350
60	2,300
55	2,250

Source: HCM 2010, Exhibit 11-17

Ramp Roadways Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*US-17 SB*
Agency or Company	*Atkins*	From/To	*6045-SC-703 to E Bay*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2038 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*4910*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*5*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.976*

Speed Inputs			Calc Speed Adj and FFS		
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f_{LW}		mph
Number of Lanes, N	*4*		f_{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	*55.0*	mph	FFS	*55.0*	mph
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures			Design (N)	
Operational (LOS)			Design (N)	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1398*	pc/h/ln	Design LOS	
S	*55.0*	mph	v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h/ln
D = v_p / S	*25.4*	pc/mi/ln	S	mph
LOS	*C*		D = v_p / S	pc/mi/ln
			Required Number of Lanes, N	

Glossary		Factor Location	
N - Number of lanes	S - Speed	E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
V - Hourly volume	D - Density	E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 11-18	TRD - Page 11-11
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 11-2, 11-3	
DDHV - Directional design hour volume			

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*US-17 SB*
Agency or Company	*Atkins*	From/To	*6045-SC-703 to E Bay*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*PM Peak*	Analysis Year	*2038 No Action*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*4709*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*4*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.980*

Speed Inputs			Calc Speed Adj and FFS		
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f_{LW}		mph
Number of Lanes, N	*4*		f_{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	*55.0*	mph	FFS	*55.0*	mph
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures			Design (N)	
Operational (LOS)			Design (N)	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1334*	pc/h/ln	Design LOS	
			v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h/ln
S	*55.0*	mph	S	mph
D = v_p / S	*24.3*	pc/mi/ln	D = v_p / S	pc/mi/ln
LOS	*C*		Required Number of Lanes, N	

Glossary		Factor Location	
N - Number of lanes	S - Speed	E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
V - Hourly volume	D - Density	E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 11-18	TRD - Page 11-11
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 11-2, 11-3	
DDHV - Directional design hour volume			

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F-3543

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	US-17 SB
Agency or Company	Atkins	Junction	6050-Off to Morrison
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2038 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp

☐ Yes ☐ On

☑ No ☐ Off

L_{up} = ft

V_u = veh/h

Freeway Number of Lanes, N	4
Ramp Number of Lanes, N	1
Acceleration Lane Length, L_A	
Deceleration Lane Length L_D	200
Freeway Volume, V_F	4910
Ramp Volume, V_R	688
Freeway Free-Flow Speed, S_{FF}	55.0
Ramp Free-Flow Speed, S_{FR}	45.0

Downstream Adj Ramp

☑ Yes ☐ On

☐ No ☑ Off

L_{down} = 885 ft

V_D = 488 veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	4910	0.90	Level	5	0	0.976	1.00	5592
Ramp	688	0.90	Level	8	0	0.962	1.00	795
UpStream								
DownStream	488	0.90	Level	9	0	0.957	1.00	567

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 0.436 using Equation (Exhibit 13-7)

V_{12} = 2886 pc/h

V_3 or V_{av34} 1353 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	5592	Exhibit 13-8	9000	No
$V_{FO} = V_F - V_R$	4797	Exhibit 13-8	9000	No
V_R	795	Exhibit 13-10	2100	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	2886	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = 27.3 (pc/mi/ln)

LOS = C (Exhibit 13-2)

Speed Determination

D_s = 0.370 (Exhibit 13-12)

S_R= 50.2 mph (Exhibit 13-12)

S_0= 59.0 mph (Exhibit 13-12)

S = 54.1 mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	US-17 SB
Agency or Company	Atkins	Junction	6050-Off to Morrison
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2038 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp

☐ Yes ☐ On

☑ No ☐ Off

L_{up} = ft

V_u = veh/h

Freeway Number of Lanes, N	4
Ramp Number of Lanes, N	1
Acceleration Lane Length, L_A	
Deceleration Lane Length L_D	200
Freeway Volume, V_F	4709
Ramp Volume, V_R	585
Freeway Free-Flow Speed, S_{FF}	55.0
Ramp Free-Flow Speed, S_{FR}	45.0

Downstream Adj Ramp

☑ Yes ☐ On

☐ No ☑ Off

L_{down} = 885 ft

V_D = 354 veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	4709	0.90	Level	4	0	0.980	1.00	5337
Ramp	585	0.90	Level	8	0	0.962	1.00	676
UpStream								
DownStream	354	0.90	Level	10	0	0.952	1.00	413

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 0.436 using Equation (Exhibit 13-7)

V_{12} = 2708 pc/h

V_3 or V_{av34} 1314 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	5337	Exhibit 13-8	9000	No
$V_{FO} = V_F - V_R$	4661	Exhibit 13-8	9000	No
V_R	676	Exhibit 13-10	2100	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	2708	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = 25.7 (pc/mi/ln)

LOS = C (Exhibit 13-2)

Speed Determination

D_s = 0.359 (Exhibit 13-12)

S_R= 50.3 mph (Exhibit 13-12)

S_0= 59.1 mph (Exhibit 13-12)

S = 54.3 mph (Exhibit 13-13)

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FREEWAY RAMP ADD OR DROP LANE ANALYSIS

ATKINS

General Information

Date Performed:	7/25/2014	Freeway/Direction	US-17 SB
Analysis Year	2038 No Action	Junction	Off to Meeting
Analysis Time Period:	AM Peak	Segment ID	6060
Project Description:	Navy Base ICTF		

Inputs

	Freeway Upstream of Ramp	Freeway Downstream of Ramp	Ramp
Number of Lanes, N	4	3	1
Free-Flow Speed, FFS (mph)	55	55	45
Volume, V (veh/h)	4,222	3,734	488
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	5%	3%	9%
%RVs, P_R	0%	0%	0%

Performance Measures

	Freeway Upstream Ramp	Freeway Downstream Ramp	Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.98	0.99	0.96
Demand Flow Rate, v_p (pc/h/ln)	1,202	1,404	567
Capacity Flow Rate, c (pc/h/ln)	2,250	2,250	2,100
v/c ratio	0.53	0.62	0.27
Density, D_{MD} (pc/mi/ln)	21.0	24.6	9.9
LOS	C	C	A

Formulas and Reference Material

$$f_{HV} = \frac{1}{1 + P_T(E_T-1)+P_R(E_R-1)}$$ HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P}$$ HCM 2010, Equation 11-2

$$D_{MD} = \frac{0.0175*v_f}{N}$$ HCM 2010, Equation 13-26

Basic Freeway Segments Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
75	2,400
70	2,400
65	2,350
60	2,300
55	2,250

Source: HCM 2010, Exhibit 11-17

Ramp Roadways Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

Diverge LOS Thresholds

LOS	Density (pc/mi/ln)
A	≤10
B	>10-20
C	>20-28
D	>28-35
E	>35
F	v/c > 1

Source: HCM 2010, Exhibit 13-2

FREEWAY RAMP ADD OR DROP LANE ANALYSIS

ATKINS

General Information

Date Performed:	7/25/2014	Freeway/Direction	US-17 SB
Analysis Year	2038 No Action	Junction	Off to Meeting
Analysis Time Period:	PM Peak	Segment ID	6060
Project Description:	Navy Base ICTF		

Inputs

	Freeway Upstream of Ramp	Freeway Downstream of Ramp	Ramp
Number of Lanes, N	4	3	1
Free-Flow Speed, FFS (mph)	55	55	45
Volume, V (veh/h)	4,124	3,770	354
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	4%	3%	10%
%RVs, P_R	0%	0%	0%

Performance Measures

	Freeway Upstream Ramp	Freeway Downstream Ramp	Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.98	0.99	0.95
Demand Flow Rate, v_p (pc/h/ln)	1,168	1,417	413
Capacity Flow Rate, c (pc/h/ln)	2,250	2,250	2,100
v/c ratio	0.52	0.63	0.20
Density, D_{MD} (pc/mi/ln)	20.4	24.8	7.2
LOS	C	C	A

Formulas and Reference Material

$$f_{HV} = \frac{1}{1 + P_T(E_T-1)+P_R(E_R-1)}$$ HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P}$$ HCM 2010, Equation 11-2

$$D_{MD} = \frac{0.0175*v_f}{N}$$ HCM 2010, Equation 13-26

Basic Freeway Segments Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
75	2,400
70	2,400
65	2,350
60	2,300
55	2,250

Source: HCM 2010, Exhibit 11-17

Ramp Roadways Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

Diverge LOS Thresholds

LOS	Density (pc/mi/ln)
A	≤10
B	>10-20
C	>20-28
D	>28-35
E	>35
F	v/c > 1

Source: HCM 2010, Exhibit 13-2

FREEWAY RAMP ADD OR DROP LANE ANALYSIS

ATKINS

General Information

Date Performed:	7/25/2014	Freeway/Direction	US-17 SB
Analysis Year	2038 No Action	Junction	Off to I-26 WB
Analysis Time Period:	AM Peak	Segment ID	6070
Project Description:	Navy Base ICTF		

Inputs

	Freeway Upstream of Ramp	Freeway Downstream of Ramp	Ramp
Number of Lanes, N	3	2	1
Free-Flow Speed, FFS (mph)	55	55	55
Volume, V (veh/h)	3,734	2,442	1,292
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	3%	3%	5%
%RVs, P_R	0%	0%	0%

Performance Measures

	Freeway Upstream Ramp	Freeway Downstream Ramp	Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.99	0.99	0.98
Demand Flow Rate, v_p (pc/h/ln)	1,404	1,377	1,471
Capacity Flow Rate, c (pc/h/ln)	2,250	2,250	2,200
v/c ratio	0.62	0.61	0.67
Density, D_{MD} (pc/mi/ln)	24.6	24.1	25.7
LOS	C	C	C

Formulas and Reference Material

$$f_{HV} = \frac{1}{1 + P_T(E_T-1)+P_R(E_R-1)}$$ HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P}$$ HCM 2010, Equation 11-2

$$D_{MD} = \frac{0.0175*v_f}{N}$$ HCM 2010, Equation 13-26

Basic Freeway Segments Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
75	2,400
70	2,400
65	2,350
60	2,300
55	2,250

Source: HCM 2010, Exhibit 11-17

Ramp Roadways Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

Diverge LOS Thresholds

LOS	Density (pc/mi/ln)
A	≤10
B	>10-20
C	>20-28
D	>28-35
E	>35
F	v/c > 1

Source: HCM 2010, Exhibit 13-2

FREEWAY RAMP ADD OR DROP LANE ANALYSIS

ATKINS

General Information

Date Performed:	7/25/2014	Freeway/Direction	US-17 SB
Analysis Year	2038 No Action	Junction	Off to I-26 WB
Analysis Time Period:	PM Peak	Segment ID	6070
Project Description:	Navy Base ICTF		

Inputs

	Freeway Upstream of Ramp	Freeway Downstream of Ramp	Ramp
Number of Lanes, N	3	2	1
Free-Flow Speed, FFS (mph)	55	55	55
Volume, V (veh/h)	3,770	2,475	1,295
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	3%	3%	4%
%RVs, P_R	0%	0%	0%

Performance Measures

	Freeway Upstream Ramp	Freeway Downstream Ramp	Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.99	0.99	0.98
Demand Flow Rate, v_p (pc/h/ln)	1,417	1,396	1,468
Capacity Flow Rate, c (pc/h/ln)	2,250	2,250	2,200
v/c ratio	0.63	0.62	0.67
Density, D_{MD} (pc/mi/ln)	24.8	24.4	25.7
LOS	C	C	C

Formulas and Reference Material

$$f_{HV} = \frac{1}{1 + P_T(E_T-1)+P_R(E_R-1)}$$ HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P}$$ HCM 2010, Equation 11-2

$$D_{MD} = \frac{0.0175*v_f}{N}$$ HCM 2010, Equation 13-26

Basic Freeway Segments Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
75	2,400
70	2,400
65	2,350
60	2,300
55	2,250

Source: HCM 2010, Exhibit 11-17

Ramp Roadways Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

Diverge LOS Thresholds

LOS	Density (pc/mi/ln)
A	≤10
B	>10-20
C	>20-28
D	>28-35
E	>35
F	v/c > 1

Source: HCM 2010, Exhibit 13-2

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	152	2888	151	76	2511	69	0	0	155	0	0	66
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	6.0	6.0	6.0	6.0	6.0	6.0			6.0			6.0
Lane Util. Factor	1.00	0.91	1.00	1.00	0.95	1.00			1.00			1.00
Frt	1.00	1.00	0.85	1.00	1.00	0.85			0.86			0.86
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00			1.00			1.00
Satd. Flow (prot)	1736	4988	1553	1736	3471	1553			1565			1580
Flt Permitted	0.95	1.00	1.00	0.95	1.00	1.00			1.00			1.00
Satd. Flow (perm)	1736	4988	1553	1736	3471	1553			1565			1580
Peak-hour factor, PHF	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Adj. Flow (vph)	169	3209	168	84	2790	77	0	0	172	0	0	73
RTOR Reduction (vph)	0	0	42	0	0	18	0	0	32	0	0	32
Lane Group Flow (vph)	169	3209	126	84	2790	59	0	0	140	0	0	41
Heavy Vehicles (%)	4%	4%	4%	4%	4%	4%	5%	5%	5%	4%	4%	4%
Turn Type	Prot	NA	Perm	Prot	NA	Perm			Over			Over
Protected Phases	5	2		1	6				1			5
Permitted Phases			2			6			1			5
Actuated Green, G (s)	9.0	67.4	67.4	10.6	69.0	69.0			10.6			9.0
Effective Green, g (s)	9.0	67.4	67.4	10.6	69.0	69.0			10.6			9.0
Actuated g/C Ratio	0.10	0.75	0.75	0.12	0.77	0.77			0.12			0.10
Clearance Time (s)	6.0	6.0	6.0	6.0	6.0	6.0			6.0			6.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0			3.0			3.0
Lane Grp Cap (vph)	173	3735	1163	204	2661	1190			184			158
v/s Ratio Prot	c0.10	0.64		0.05	c0.80				0.09			0.03
v/s Ratio Perm			0.08			0.04						
v/c Ratio	0.98	0.86	0.11	0.41	1.05	0.05			0.76			0.26
Uniform Delay, d1	40.4	8.0	3.1	36.8	10.5	2.5			38.5			37.4
Progression Factor	1.00	1.00	1.00	1.14	2.53	2.21			1.00			1.00
Incremental Delay, d2	61.0	2.8	0.2	0.4	25.5	0.0			16.9			0.9
Delay (s)	101.4	10.8	3.3	42.2	52.1	5.7			55.4			38.3
Level of Service	F	B	A	D	D	A			E			D
Approach Delay (s)		14.7			50.6			55.4			38.3	
Approach LOS		B			D			E			D	

Intersection Summary			
HCM 2000 Control Delay	31.7	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	1.04		
Actuated Cycle Length (s)	90.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	87.8%	ICU Level of Service	E
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	121	3293	154	73	2451	50	0	0	155	0	0	66
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	6.0	6.0	6.0	6.0	6.0	6.0			6.0			6.0
Lane Util. Factor	1.00	0.91	1.00	1.00	0.95	1.00			1.00			1.00
Frt	1.00	1.00	0.85	1.00	1.00	0.85			0.86			0.86
Flt Protected	0.95	1.00	1.00	0.95	1.00	1.00			1.00			1.00
Satd. Flow (prot)	1736	4988	1553	1736	3471	1553			1580			1580
Flt Permitted	0.95	1.00	1.00	0.95	1.00	1.00			1.00			1.00
Satd. Flow (perm)	1736	4988	1553	1736	3471	1553			1580			1580
Peak-hour factor, PHF	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Adj. Flow (vph)	134	3659	171	81	2723	56	0	0	172	0	0	73
RTOR Reduction (vph)	0	0	21	0	0	9	0	0	17	0	0	17
Lane Group Flow (vph)	134	3659	150	81	2723	47	0	0	155	0	0	56
Heavy Vehicles (%)	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%	4%
Turn Type	Prot	NA	Perm	Prot	NA	Perm			Over			Over
Protected Phases	5	2		1	6				1			5
Permitted Phases			2			6			1			5
Actuated Green, G (s)	16.0	138.9	138.9	19.1	142.0	142.0			19.1			16.0
Effective Green, g (s)	16.0	138.9	138.9	19.1	142.0	142.0			19.1			16.0
Actuated g/C Ratio	0.09	0.82	0.82	0.11	0.84	0.84			0.11			0.09
Clearance Time (s)	6.0	6.0	6.0	6.0	6.0	6.0			6.0			6.0
Vehicle Extension (s)	3.0	3.0	3.0	3.0	3.0	3.0			3.0			3.0
Lane Grp Cap (vph)	163	4075	1268	195	2899	1297			177			148
v/s Ratio Prot	0.08	0.73		0.05	c0.78				c0.10			0.04
v/s Ratio Perm			0.10			0.03						
v/c Ratio	0.82	0.90	0.12	0.42	0.94	0.04			0.88			0.38
Uniform Delay, d1	75.6	10.7	3.1	70.3	10.7	2.4			74.3			72.3
Progression Factor	1.00	1.00	1.00	0.82	2.16	0.09			1.00			1.00
Incremental Delay, d2	27.1	3.6	0.2	0.6	3.4	0.0			35.0			1.6
Delay (s)	102.7	14.3	3.3	58.4	26.5	0.2			109.3			73.9
Level of Service	F	B	A	E	C	A			F			E
Approach Delay (s)		16.8			26.9			109.3			73.9	
Approach LOS		B			C			F			E	

Intersection Summary			
HCM 2000 Control Delay	23.7	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.95		
Actuated Cycle Length (s)	170.0	Sum of lost time (s)	12.0
Intersection Capacity Utilization	85.3%	ICU Level of Service	E
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	460	2240	343	362	2399	138	177	262	179	69	283	80
Number	5	2	12	1	6	16	3	8	18	7	4	14
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1827	1827	1827	1810	1810	1810	1863	1863	1863	1863	1863	1863
Adj Flow Rate, veh/h	511	2489	381	402	2666	153	197	291	199	77	314	89
Adj No. of Lanes	2	3	1	2	3	1	1	2	1	1	2	1
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Percent Heavy Veh, %	4	4	4	5	5	5	2	2	2	2	2	2
Cap, veh/h	488	2785	1005	436	2690	913	198	455	410	173	315	369
Arrive On Green	0.29	1.00	1.00	0.13	0.54	0.54	0.09	0.13	0.13	0.05	0.09	0.09
Sat Flow, veh/h	3375	4988	1553	3343	4940	1538	1774	3539	1583	1774	3539	1583
Grp Volume(v), veh/h	511	2489	381	402	2666	153	197	291	199	77	314	89
Grp Sat Flow(s),veh/h/ln	1688	1663	1553	1672	1647	1538	1774	1770	1583	1774	1770	1583
Q Serve(g_s), s	26.0	0.0	0.0	21.4	96.1	8.1	16.0	14.1	19.2	7.0	16.0	8.2
Cycle Q Clear(g_c), s	26.0	0.0	0.0	21.4	96.1	8.1	16.0	14.1	19.2	7.0	16.0	8.2
Prop In Lane	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Lane Grp Cap(c), veh/h	488	2785	1005	436	2690	913	198	455	410	173	315	369
V/C Ratio(X)	1.05	0.89	0.38	0.92	0.99	0.17	1.00	0.64	0.48	0.45	1.00	0.24
Avail Cap(c_a), veh/h	488	2785	1005	446	2690	913	198	455	410	174	315	369
HCM Platoon Ratio	2.00	2.00	2.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	0.40	0.40	0.40	0.09	0.09	0.09	1.00	1.00	1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	64.0	0.0	0.0	77.3	40.6	16.5	69.2	74.5	56.5	70.0	82.0	56.1
Incr Delay (d2), s/veh	39.3	2.1	0.4	3.4	3.6	0.0	62.6	3.0	0.9	1.8	50.2	0.3
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	14.7	0.5	0.1	10.1	44.3	3.4	5.4	7.1	8.5	3.5	10.0	3.6
LnGrp Delay(d),s/veh	103.3	2.1	0.4	80.7	44.2	16.5	131.8	77.4	57.4	71.8	132.2	56.4
LnGrp LOS	F	A	A	F	D	B	F	E	E	E	F	E
Approach Vol, veh/h		3381			3221			687			480	
Approach Delay, s/veh		17.2			47.4			87.2			108.4	
Approach LOS		B			D			F			F	

Timer	1	2	3	4	5	6	7	8
Assigned Phs	1	2	3	4	5	6	7	8
Phs Duration (G+Y+Rc), s	29.5	106.5	22.0	22.0	32.0	104.0	14.8	29.2
Change Period (Y+Rc), s	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0
Max Green Setting (Gmax), s	24.0	100.0	16.0	16.0	26.0	98.0	9.0	23.0
Max Q Clear Time (g_c+I1), s	23.4	2.0	18.0	18.0	28.0	98.1	9.0	21.2
Green Ext Time (p_c), s	0.1	96.4	0.0	0.0	0.0	0.0	0.0	0.9

Intersection Summary	
HCM 2010 Ctrl Delay	41.6
HCM 2010 LOS	D

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	432	2693	323	309	2170	133	223	270	330	128	232	181
Number	5	2	12	1	6	16	3	8	18	7	4	14
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1827	1827	1827	1827	1827	1827	1863	1863	1863	1863	1863	1863
Adj Flow Rate, veh/h	480	2992	359	343	2411	148	248	300	367	142	258	201
Adj No. of Lanes	2	3	1	2	3	1	1	2	1	1	2	1
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Percent Heavy Veh, %	4	4	4	4	4	4	2	2	2	2	2	2
Cap, veh/h	496	2846	1041	318	2582	904	241	458	354	195	333	382
Arrive On Green	0.29	1.00	1.00	0.09	0.52	0.52	0.10	0.13	0.13	0.06	0.09	0.09
Sat Flow, veh/h	3375	4988	1553	3375	4988	1553	1774	3539	1583	1774	3539	1583
Grp Volume(v), veh/h	480	2992	359	343	2411	148	248	300	367	142	258	201
Grp Sat Flow(s),veh/h/ln	1688	1663	1553	1688	1663	1553	1774	1770	1583	1774	1770	1583
Q Serve(g_s), s	23.8	97.0	0.0	16.0	76.7	7.5	17.0	13.7	22.0	11.0	12.1	16.0
Cycle Q Clear(g_c), s	23.8	97.0	0.0	16.0	76.7	7.5	17.0	13.7	22.0	11.0	12.1	16.0
Prop In Lane	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Lane Grp Cap(c), veh/h	496	2846	1041	318	2582	904	241	458	354	195	333	382
V/C Ratio(X)	0.97	1.05	0.34	1.08	0.93	0.16	1.03	0.65	1.04	0.73	0.77	0.53
Avail Cap(c_a), veh/h	496	2846	1041	318	2582	904	241	458	354	195	333	382
HCM Platoon Ratio	2.00	2.00	2.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	0.32	0.32	0.32	0.25	0.25	0.25	1.00	1.00	1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	59.6	0.0	0.0	77.0	38.3	16.4	65.3	70.4	66.0	66.6	75.2	56.1
Incr Delay (d2), s/veh	15.7	26.7	0.3	49.5	2.3	0.1	65.7	3.4	57.7	13.0	10.8	1.3
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	12.1	7.0	0.1	9.6	35.6	3.2	4.4	6.9	22.3	1.9	6.5	8.3
LnGrp Delay(d),s/veh	75.3	26.7	0.3	126.5	40.5	16.5	131.1	73.7	123.7	79.7	86.1	57.4
LnGrp LOS	E	F	A	F	D	B	F	E	F	E	F	E
Approach Vol, veh/h		3831			2902			915			601	
Approach Delay, s/veh		30.3			49.5			109.3			75.0	
Approach LOS		C			D			F			E	

Timer	1	2	3	4	5	6	7	8
Assigned Phs	1	2	3	4	5	6	7	8
Phs Duration (G+Y+Rc), s	22.0	103.0	23.0	22.0	31.0	94.0	17.0	28.0
Change Period (Y+Rc), s	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0
Max Green Setting (Gmax), s	16.0	97.0	17.0	16.0	25.0	88.0	11.0	22.0
Max Q Clear Time (g_c+I1), s	18.0	99.0	19.0	18.0	25.8	78.7	13.0	24.0
Green Ext Time (p_c), s	0.0	0.0	0.0	0.0	0.0	9.3	0.0	0.0

Intersection Summary	
HCM 2010 Ctrl Delay	49.1
HCM 2010 LOS	D

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	253	2058	177	214	2562	304	129	196	190	204	218	208
Number	5	2	12	1	6	16	3	8	18	7	4	14
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1810	1810	1810	1810	1810	1810	1863	1863	1863	1863	1863	1863
Adj Flow Rate, veh/h	281	2287	197	238	2847	338	143	218	211	227	242	231
Adj No. of Lanes	1	3	1	1	3	1	1	1	1	2	1	1
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Percent Heavy Veh, %	5	5	5	5	5	5	2	2	2	2	2	2
Cap, veh/h	285	2744	974	254	2690	948	138	238	378	249	228	387
Arrive On Green	0.12	0.56	0.56	0.22	1.00	1.00	0.08	0.13	0.13	0.07	0.12	0.12
Sat Flow, veh/h	1723	4940	1538	1723	4940	1538	1774	1863	1583	3442	1863	1583
Grp Volume(v), veh/h	281	2287	197	238	2847	338	143	218	211	227	242	231
Grp Sat Flow(s),veh/h/ln	1723	1647	1538	1723	1647	1538	1774	1863	1583	1721	1863	1583
Q Serve(g_s), s	21.5	69.0	9.7	17.7	0.0	0.0	14.0	20.8	21.1	11.8	22.0	22.0
Cycle Q Clear(g_c), s	21.5	69.0	9.7	17.7	0.0	0.0	14.0	20.8	21.1	11.8	22.0	22.0
Prop In Lane	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Lane Grp Cap(c), veh/h	285	2744	974	254	2690	948	138	238	378	249	228	387
V/C Ratio(X)	0.99	0.83	0.20	0.94	1.06	0.36	1.04	0.92	0.56	0.91	1.06	0.60
Avail Cap(c_a), veh/h	285	2744	974	302	2690	948	138	238	378	249	228	387
HCM Platoon Ratio	1.00	1.00	1.00	2.00	2.00	2.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	0.42	0.42	0.42	0.37	0.37	0.37	1.00	1.00	1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	54.0	33.1	13.9	49.1	0.0	0.0	83.0	77.5	60.1	82.9	79.0	60.2
Incr Delay (d2), s/veh	30.6	1.3	0.2	16.7	30.3	0.4	86.6	36.4	1.8	34.8	77.3	2.5
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	16.3	31.7	4.2	12.7	7.5	0.1	10.2	13.1	9.4	6.8	16.2	10.5
LnGrp Delay(d),s/veh	84.5	34.5	14.1	65.8	30.3	0.4	170.0	114.0	61.9	117.8	156.3	62.7
LnGrp LOS	F	C	B	E	F	A	F	F	E	F	F	E
Approach Vol, veh/h		2765			3423			572			700	
Approach Delay, s/veh		38.1			29.8			108.8			112.9	
Approach LOS		D			C			F			F	

Timer	1	2	3	4	5	6	7	8
Assigned Phs	1	2	3	4	5	6	7	8
Phs Duration (G+Y+Rc), s	26.0	106.0	20.0	28.0	28.0	104.0	19.0	29.0
Change Period (Y+Rc), s	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0
Max Green Setting (Gmax), s	25.0	95.0	14.0	22.0	22.0	98.0	13.0	23.0
Max Q Clear Time (g_c+I1), s	19.7	71.0	16.0	24.0	23.5	2.0	13.8	23.1
Green Ext Time (p_c), s	0.3	23.9	0.0	0.0	0.0	94.5	0.0	0.0

Intersection Summary	
HCM 2010 Ctrl Delay	46.7
HCM 2010 LOS	D

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	313	2712	126	222	2257	185	110	180	267	226	206	245
Number	5	2	12	1	6	16	3	8	18	7	4	14
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1827	1827	1827	1827	1827	1827	1863	1863	1863	1863	1863	1863
Adj Flow Rate, veh/h	348	3013	140	247	2508	206	122	200	297	251	229	272
Adj No. of Lanes	1	3	1	1	3	1	1	1	1	2	1	1
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Percent Heavy Veh, %	4	4	4	4	4	4	2	2	2	2	2	2
Cap, veh/h	334	2904	1005	216	2582	913	115	197	326	243	208	438
Arrive On Green	0.16	0.58	0.58	0.13	0.69	0.69	0.06	0.11	0.11	0.07	0.11	0.11
Sat Flow, veh/h	1740	4988	1553	1740	4988	1553	1774	1863	1583	3442	1863	1583
Grp Volume(v), veh/h	348	3013	140	247	2508	206	122	200	297	251	229	272
Grp Sat Flow(s),veh/h/ln	1740	1663	1553	1740	1663	1553	1774	1863	1583	1721	1863	1583
Q Serve(g_s), s	28.0	99.0	5.9	17.0	80.4	7.3	11.0	18.0	18.0	12.0	19.0	19.0
Cycle Q Clear(g_c), s	28.0	99.0	5.9	17.0	80.4	7.3	11.0	18.0	18.0	12.0	19.0	19.0
Prop In Lane	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Lane Grp Cap(c), veh/h	334	2904	1005	216	2582	913	115	197	326	243	208	438
V/C Ratio(X)	1.04	1.04	0.14	1.14	0.97	0.23	1.06	1.01	0.91	1.03	1.10	0.62
Avail Cap(c_a), veh/h	334	2904	1005	216	2582	913	115	197	326	243	208	438
HCM Platoon Ratio	1.00	1.00	1.00	1.33	1.33	1.33	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	0.09	0.09	0.09	0.69	0.69	0.69	1.00	1.00	1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	61.7	35.5	11.6	59.3	25.3	10.3	79.5	76.0	66.0	79.0	75.5	53.7
Incr Delay (d2), s/veh	27.7	18.2	0.0	94.9	9.4	0.4	101.9	67.8	28.5	66.6	91.7	2.7
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.2	0.1	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	18.2	50.1	2.5	15.8	38.6	3.2	8.6	13.0	16.2	8.0	15.1	11.5
LnGrp Delay(d),s/veh	89.4	53.7	11.7	154.2	34.7	10.7	181.6	143.9	94.4	145.7	167.2	56.4
LnGrp LOS	F	F	B	F	C	B	F	F	F	F	F	E
Approach Vol, veh/h		3501			2961			619			752	
Approach Delay, s/veh		55.6			43.0			127.6			119.9	
Approach LOS		E			D			F			F	

Timer	1	2	3	4	5	6	7	8
Assigned Phs	1	2	3	4	5	6	7	8
Phs Duration (G+Y+Rc), s	23.0	105.0	17.0	25.0	34.0	94.0	18.0	24.0
Change Period (Y+Rc), s	6.0	6.0	6.0	6.0	6.0	6.0	6.0	6.0
Max Green Setting (Gmax), s	17.0	99.0	11.0	19.0	28.0	88.0	12.0	18.0
Max Q Clear Time (g_c+I1), s	19.0	101.0	13.0	21.0	30.0	82.4	14.0	20.0
Green Ext Time (p_c), s	0.0	0.0	0.0	0.0	0.0	5.6	0.0	0.0

Intersection Summary	
HCM 2010 Ctrl Delay	62.7
HCM 2010 LOS	E

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Volume (veh/h)	2331	121	131	2995	85	123
Number	2	12	1	6	3	18
Initial Q (Qb), veh	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)		1.00	1.00		1.00	1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1810	1810	1810	1810	1845	1845
Adj Flow Rate, veh/h	2590	134	146	3328	94	137
Adj No. of Lanes	3	1	1	3	1	1
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90
Percent Heavy Veh, %	5	5	5	5	3	3
Cap, veh/h	2979	1081	274	3789	175	309
Arrive On Green	0.80	0.80	0.13	1.00	0.10	0.10
Sat Flow, veh/h	5103	1538	1723	5103	1757	1568
Grp Volume(v), veh/h	2590	134	146	3328	94	137
Grp Sat Flow(s),veh/h/ln	1647	1538	1723	1647	1757	1568
Q Serve(g_s), s	30.9	1.3	2.3	0.0	4.6	6.9
Cycle Q Clear(g_c), s	30.9	1.3	2.3	0.0	4.6	6.9
Prop In Lane		1.00	1.00		1.00	1.00
Lane Grp Cap(c), veh/h	2979	1081	274	3789	175	309
V/C Ratio(X)	0.87	0.12	0.53	0.88	0.54	0.44
Avail Cap(c_a), veh/h	2979	1081	279	3789	176	310
HCM Platoon Ratio	1.33	1.33	1.33	1.33	1.00	1.00
Upstream Filter(I)	0.44	0.44	0.09	0.09	1.00	1.00
Uniform Delay (d), s/veh	6.6	2.1	18.5	0.0	38.5	31.8
Incr Delay (d2), s/veh	1.7	0.1	0.2	0.3	3.2	1.0
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	13.8	0.8	2.2	0.1	2.4	3.1
LnGrp Delay(d),s/veh	8.3	2.2	18.7	0.3	41.7	32.8
LnGrp LOS	A	A	B	A	D	C
Approach Vol, veh/h	2724			3474	231	
Approach Delay, s/veh	8.0			1.1	36.4	
Approach LOS	A			A	D	

Timer	1	2	3	4	5	6	7	8
Assigned Phs	1	2				6		8
Phs Duration (G+Y+Rc), s	14.8	60.3				75.0		15.0
Change Period (Y+Rc), s	6.0	6.0				6.0		6.0
Max Green Setting (Gmax), s	9.0	54.0				69.0		9.0
Max Q Clear Time (g_c+I1), s	4.3	32.9				2.0		8.9
Green Ext Time (p_c), s	0.1	21.1				66.6		0.0

Intersection Summary	
HCM 2010 Ctrl Delay	5.3
HCM 2010 LOS	A

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Lane Configurations						
Volume (veh/h)	3093	112	138	2587	77	152
Number	2	12	1	6	3	18
Initial Q (Qb), veh	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)		1.00	1.00		1.00	1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1827	1827	1827	1827	1863	1863
Adj Flow Rate, veh/h	3437	124	153	2874	86	169
Adj No. of Lanes	3	1	1	3	1	1
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90
Percent Heavy Veh, %	4	4	4	4	2	2
Cap, veh/h	3865	1304	171	4313	115	189
Arrive On Green	1.00	1.00	0.11	1.00	0.06	0.06
Sat Flow, veh/h	5152	1553	1740	5152	1774	1583
Grp Volume(v), veh/h	3437	124	153	2874	86	169
Grp Sat Flow(s),veh/h/ln	1663	1553	1740	1663	1774	1583
Q Serve(g_s), s	0.0	0.0	7.1	0.0	8.1	11.0
Cycle Q Clear(g_c), s	0.0	0.0	7.1	0.0	8.1	11.0
Prop In Lane		1.00	1.00		1.00	1.00
Lane Grp Cap(c), veh/h	3865	1304	171	4313	115	189
V/C Ratio(X)	0.89	0.10	0.89	0.67	0.75	0.89
Avail Cap(c_a), veh/h	3865	1304	219	4313	115	189
HCM Platoon Ratio	2.00	2.00	2.00	2.00	1.00	1.00
Upstream Filter(I)	0.09	0.09	0.21	0.21	1.00	1.00
Uniform Delay (d), s/veh	0.0	0.0	45.0	0.0	78.1	73.8
Incr Delay (d2), s/veh	0.3	0.0	8.4	0.2	23.5	37.7
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	0.1	0.0	7.4	0.1	4.7	9.8
LnGrp Delay(d),s/veh	0.3	0.0	53.4	0.2	101.7	111.5
LnGrp LOS	A	A	D	A	F	F
Approach Vol, veh/h	3561			3027	255	
Approach Delay, s/veh	0.3			2.9	108.2	
Approach LOS	A			A	F	

Timer	1	2	3	4	5	6	7	8
Assigned Phs	1	2				6		8
Phs Duration (G+Y+Rc), s	15.3	137.7				153.0		17.0
Change Period (Y+Rc), s	6.0	6.0				6.0		6.0
Max Green Setting (Gmax), s	14.0	127.0				147.0		11.0
Max Q Clear Time (g_c+I1), s	9.1	2.0				2.0		13.0
Green Ext Time (p_c), s	0.1	123.6				143.1		0.0

Intersection Summary	
HCM 2010 Ctrl Delay	5.5
HCM 2010 LOS	A

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	284	2048	122	195	2775	410	160	94	183	245	107	191
Number	5	2	12	1	6	16	3	8	18	7	4	14
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1810	1810	1810	1810	1810	1810	1863	1863	1863	1863	1863	1863
Adj Flow Rate, veh/h	316	2276	136	217	3083	456	178	104	203	272	119	212
Adj No. of Lanes	1	3	1	1	3	1	2	1	1	2	1	1
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Percent Heavy Veh, %	5	5	5	5	5	5	2	2	2	2	2	2
Cap, veh/h	260	3060	1089	238	2772	1000	315	166	251	315	166	343
Arrive On Green	0.26	1.00	1.00	0.07	0.56	0.56	0.09	0.09	0.09	0.09	0.09	0.09
Sat Flow, veh/h	1723	4940	1538	1723	4940	1538	3548	1863	1583	3548	1863	1583
Grp Volume(v), veh/h	316	2276	136	217	3083	456	178	104	203	272	119	212
Grp Sat Flow(s),veh/h/ln	1723	1647	1538	1723	1647	1538	1774	1863	1583	1774	1863	1583
Q Serve(g_s), s	23.0	0.0	0.0	10.1	101.0	26.5	8.7	9.7	16.0	13.6	11.2	16.0
Cycle Q Clear(g_c), s	23.0	0.0	0.0	10.1	101.0	26.5	8.7	9.7	16.0	13.6	11.2	16.0
Prop In Lane	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Lane Grp Cap(c), veh/h	260	3060	1089	238	2772	1000	315	166	251	315	166	343
V/C Ratio(X)	1.21	0.74	0.12	0.91	1.11	0.46	0.56	0.63	0.81	0.86	0.72	0.62
Avail Cap(c_a), veh/h	260	3060	1089	357	2772	1000	315	166	251	315	166	343
HCM Platoon Ratio	2.00	2.00	2.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	0.42	0.42	0.42	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	56.9	0.0	0.0	25.7	39.5	15.7	78.7	79.1	73.1	80.9	79.8	63.8
Incr Delay (d2), s/veh	110.8	0.7	0.1	20.2	56.3	1.5	2.3	7.3	17.7	21.0	14.0	3.3
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	20.9	0.2	0.0	11.9	60.1	14.5	4.4	5.3	11.0	7.6	6.4	9.9
LnGrp Delay(d),s/veh	167.7	0.7	0.1	45.9	95.8	17.2	81.0	86.5	90.8	101.9	93.8	67.1
LnGrp LOS	F	A	A	D	F	B	F	F	F	F	F	E
Approach Vol, veh/h		2728			3756			485			603	
Approach Delay, s/veh		20.0			83.4			86.3			88.1	
Approach LOS		C			F			F			F	

Timer	1	2	3	4	5	6	7	8
Assigned Phs	1	2		4	5	6		8
Phs Duration (G+Y+Rc), s	18.5	117.5		22.0	29.0	107.0		22.0
Change Period (Y+Rc), s	6.0	6.0		6.0	6.0	6.0		6.0
Max Green Setting (Gmax), s	25.0	99.0		16.0	23.0	101.0		16.0
Max Q Clear Time (g_c+I1), s	12.1	2.0		18.0	25.0	103.0		18.0
Green Ext Time (p_c), s	0.5	96.1		0.0	0.0	0.0		0.0

Intersection Summary	
HCM 2010 Ctrl Delay	61.1
HCM 2010 LOS	E

Notes

User approved volume balancing among the lanes for turning movement.

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	252	2864	129	194	2385	272	120	97	194	348	172	220
Number	5	2	12	1	6	16	3	8	18	7	4	14
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1827	1827	1827	1827	1827	1827	1863	1863	1863	1863	1863	1863
Adj Flow Rate, veh/h	280	3182	143	216	2650	302	134	107	216	387	191	244
Adj No. of Lanes	1	3	1	1	3	1	2	1	1	2	1	1
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Percent Heavy Veh, %	4	4	4	4	4	4	2	2	2	2	2	2
Cap, veh/h	258	2875	1041	186	2670	996	334	175	279	376	197	363
Arrive On Green	0.25	1.00	1.00	0.08	0.54	0.54	0.09	0.09	0.09	0.11	0.11	0.11
Sat Flow, veh/h	1740	4988	1553	1740	4988	1553	3548	1863	1583	3548	1863	1583
Grp Volume(v), veh/h	280	3182	143	216	2650	302	134	107	216	387	191	244
Grp Sat Flow(s),veh/h/ln	1740	1663	1553	1740	1663	1553	1774	1863	1583	1774	1863	1583
Q Serve(g_s), s	21.0	98.0	0.0	14.0	89.6	14.7	6.0	9.4	16.0	18.0	17.4	18.0
Cycle Q Clear(g_c), s	21.0	98.0	0.0	14.0	89.6	14.7	6.0	9.4	16.0	18.0	17.4	18.0
Prop In Lane	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Lane Grp Cap(c), veh/h	258	2875	1041	186	2670	996	334	175	279	376	197	363
V/C Ratio(X)	1.09	1.11	0.14	1.16	0.99	0.30	0.40	0.61	0.77	1.03	0.97	0.67
Avail Cap(c_a), veh/h	258	2875	1041	186	2670	996	334	175	279	376	197	363
HCM Platoon Ratio	2.00	2.00	2.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	0.31	0.31	0.31	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	52.9	0.0	0.0	61.6	39.2	13.6	72.5	74.0	66.8	76.0	75.7	59.7
Incr Delay (d2), s/veh	57.0	50.0	0.1	117.0	15.8	0.8	0.8	6.0	12.6	54.4	54.8	4.8
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	16.1	13.3	0.0	14.7	44.9	8.4	3.0	5.1	10.6	11.7	12.0	10.9
LnGrp Delay(d),s/veh	109.9	50.0	0.1	178.6	54.9	14.4	73.3	80.1	79.3	130.4	130.5	64.4
LnGrp LOS	F	F	A	F	D	B	E	F	E	F	F	E
Approach Vol, veh/h		3605			3168			457			822	
Approach Delay, s/veh		52.6			59.5			77.7			110.8	
Approach LOS		D			E			E			F	

Timer	1	2	3	4	5	6	7	8
Assigned Phs	1	2		4	5	6		8
Phs Duration (G+Y+Rc), s	20.0	104.0		24.0	27.0	97.0		22.0
Change Period (Y+Rc), s	6.0	6.0		6.0	6.0	6.0		6.0
Max Green Setting (Gmax), s	14.0	98.0		18.0	21.0	91.0		16.0
Max Q Clear Time (g_c+I1), s	16.0	100.0		20.0	23.0	91.6		18.0
Green Ext Time (p_c), s	0.0	0.0		0.0	0.0	0.0		0.0

Intersection Summary	
HCM 2010 Ctrl Delay	62.7
HCM 2010 LOS	E

Notes

User approved volume balancing among the lanes for turning movement.

Appendix E
Traffic Analysis Worksheets

2038 Design Year

No Action Alternative

North Charleston Intersections

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	0	0	0	0	193	0	0	0	0	0	1845	389
Number				7	4	14				5	2	12
Initial Q (Qb), veh				0	0	0				0	0	0
Ped-Bike Adj(A_pbT)				1.00		1.00				1.00		1.00
Parking Bus, Adj				1.00	1.00	1.00				1.00	1.00	1.00
Adj Sat Flow, veh/h/ln				0	1792	0				0	1827	1827
Adj Flow Rate, veh/h				0	214	0				0	2050	432
Adj No. of Lanes				0	2	0				0	3	1
Peak Hour Factor				0.90	0.90	0.90				0.90	0.90	0.90
Percent Heavy Veh, %				0	6	0				0	4	4
Cap, veh/h				0	460	0				0	3398	1058
Arrive On Green				0.00	0.13	0.00				0.00	0.68	0.68
Sat Flow, veh/h				0	3585	0				0	5152	1553
Grp Volume(v), veh/h				0	214	0				0	2050	432
Grp Sat Flow(s),veh/h/ln				0	1703	0				0	1663	1553
Q Serve(g_s), s				0.0	3.8	0.0				0.0	14.5	8.0
Cycle Q Clear(g_c), s				0.0	3.8	0.0				0.0	14.5	8.0
Prop In Lane				0.00		0.00				0.00		1.00
Lane Grp Cap(c), veh/h				0	460	0				0	3398	1058
V/C Ratio(X)				0.00	0.47	0.00				0.00	0.60	0.41
Avail Cap(c_a), veh/h				0	730	0				0	4888	1522
HCM Platoon Ratio				1.00	1.00	1.00				1.00	1.00	1.00
Upstream Filter(I)				0.00	1.00	0.00				0.00	1.00	1.00
Uniform Delay (d), s/veh				0.0	26.1	0.0				0.0	5.6	4.6
Incr Delay (d2), s/veh				0.0	0.7	0.0				0.0	0.2	0.3
Initial Q Delay(d3),s/veh				0.0	0.0	0.0				0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln				0.0	1.8	0.0				0.0	6.5	3.4
LnGrp Delay(d),s/veh				0.0	26.8	0.0				0.0	5.8	4.8
LnGrp LOS					C						A	A
Approach Vol, veh/h					214						2482	
Approach Delay, s/veh					26.8						5.6	
Approach LOS					C						A	

Timer	1	2	3	4	5	6	7	8
Assigned Phs		2		4				
Phs Duration (G+Y+Rc), s		50.5		14.8				
Change Period (Y+Rc), s		6.0		6.0				
Max Green Setting (Gmax), s		64.0		14.0				
Max Q Clear Time (g_c+I1), s		16.5		5.8				
Green Ext Time (p_c), s		28.0		0.7				

Intersection Summary	
HCM 2010 Ctrl Delay	7.3
HCM 2010 LOS	A

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	0	0	0	0	222	0	0	0	0	0	1168	307
Number				7	4	14				5	2	12
Initial Q (Qb), veh				0	0	0				0	0	0
Ped-Bike Adj(A_pbT)				1.00		1.00				1.00		1.00
Parking Bus, Adj				1.00	1.00	1.00				1.00	1.00	1.00
Adj Sat Flow, veh/h/ln				0	1810	0				0	1827	1827
Adj Flow Rate, veh/h				0	247	0				0	1298	341
Adj No. of Lanes				0	2	0				0	3	1
Peak Hour Factor				0.90	0.90	0.90				0.90	0.90	0.90
Percent Heavy Veh, %				0	5	0				0	4	4
Cap, veh/h				0	675	0				0	2634	820
Arrive On Green				0.00	0.20	0.00				0.00	0.53	0.53
Sat Flow, veh/h				0	3619	0				0	5152	1553
Grp Volume(v), veh/h				0	247	0				0	1298	341
Grp Sat Flow(s),veh/h/ln				0	1719	0				0	1663	1553
Q Serve(g_s), s				0.0	2.7	0.0				0.0	7.2	5.8
Cycle Q Clear(g_c), s				0.0	2.7	0.0				0.0	7.2	5.8
Prop In Lane				0.00		0.00				0.00		1.00
Lane Grp Cap(c), veh/h				0	675	0				0	2634	820
V/C Ratio(X)				0.00	0.37	0.00				0.00	0.49	0.42
Avail Cap(c_a), veh/h				0	1738	0				0	6416	1998
HCM Platoon Ratio				1.00	1.00	1.00				1.00	1.00	1.00
Upstream Filter(I)				0.00	1.00	0.00				0.00	1.00	1.00
Uniform Delay (d), s/veh				0.0	15.1	0.0				0.0	6.6	6.2
Incr Delay (d2), s/veh				0.0	0.3	0.0				0.0	0.1	0.3
Initial Q Delay(d3),s/veh				0.0	0.0	0.0				0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln				0.0	1.3	0.0				0.0	3.3	2.5
LnGrp Delay(d),s/veh				0.0	15.5	0.0				0.0	6.7	6.6
LnGrp LOS					B						A	A
Approach Vol, veh/h					247						1639	
Approach Delay, s/veh					15.5						6.7	
Approach LOS					B						A	

Timer	1	2	3	4	5	6	7	8
Assigned Phs		2		4				
Phs Duration (G+Y+Rc), s		29.0		14.5				
Change Period (Y+Rc), s		6.0		6.0				
Max Green Setting (Gmax), s		56.0		22.0				
Max Q Clear Time (g_c+I1), s		9.2		4.7				
Green Ext Time (p_c), s		13.8		1.3				

Intersection Summary	
HCM 2010 Ctrl Delay	7.8
HCM 2010 LOS	A

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	0	382	0	0	0	0	0	954	196	0	0	0
Number	3	8	18				1	6	16			
Initial Q (Qb), veh	0	0	0				0	0	0			
Ped-Bike Adj(A_pbT)	1.00		1.00				1.00		1.00			
Parking Bus, Adj	1.00	1.00	1.00				1.00	1.00	1.00			
Adj Sat Flow, veh/h/ln	0	1792	0				0	1727	1727			
Adj Flow Rate, veh/h	0	424	0				0	1060	218			
Adj No. of Lanes	0	2	0				0	3	1			
Peak Hour Factor	0.90	0.90	0.90				0.90	0.90	0.90			
Percent Heavy Veh, %	0	6	0				0	10	10			
Cap, veh/h	0	793	0				0	2136	665			
Arrive On Green	0.00	0.23	0.00				0.00	0.45	0.45			
Sat Flow, veh/h	0	3585	0				0	4871	1468			
Grp Volume(v), veh/h	0	424	0				0	1060	218			
Grp Sat Flow(s),veh/h/ln	0	1703	0				0	1572	1468			
Q Serve(g_s), s	0.0	4.2	0.0				0.0	6.1	3.6			
Cycle Q Clear(g_c), s	0.0	4.2	0.0				0.0	6.1	3.6			
Prop In Lane	0.00		0.00				0.00		1.00			
Lane Grp Cap(c), veh/h	0	793	0				0	2136	665			
V/C Ratio(X)	0.00	0.53	0.00				0.00	0.50	0.33			
Avail Cap(c_a), veh/h	0	2317	0				0	5183	1614			
HCM Platoon Ratio	1.00	1.00	1.00				1.00	1.00	1.00			
Upstream Filter(I)	0.00	1.00	0.00				0.00	1.00	1.00			
Uniform Delay (d), s/veh	0.0	12.8	0.0				0.0	7.4	6.7			
Incr Delay (d2), s/veh	0.0	0.6	0.0				0.0	0.2	0.3			
Initial Q Delay(d3),s/veh	0.0	0.0	0.0				0.0	0.0	0.0			
%ile BackOfQ(50%),veh/ln	0.0	2.0	0.0				0.0	2.6	1.5			
LnGrp Delay(d),s/veh	0.0	13.4	0.0				0.0	7.6	7.0			
LnGrp LOS		B						A	A			
Approach Vol, veh/h		424						1278				
Approach Delay, s/veh		13.4						7.5				
Approach LOS		B						A				

Timer	1	2	3	4	5	6	7	8
Assigned Phs						6		8
Phs Duration (G+Y+Rc), s						23.3		14.9
Change Period (Y+Rc), s						6.0		6.0
Max Green Setting (Gmax), s						42.0		26.0
Max Q Clear Time (g_c+I1), s						8.1		6.2
Green Ext Time (p_c), s						9.2		2.6

Intersection Summary	
HCM 2010 Ctrl Delay	8.9
HCM 2010 LOS	A

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	0	313	0	0	0	0	0	1668	237	0	0	0
Number	3	8	18				1	6	16			
Initial Q (Qb), veh	0	0	0				0	0	0			
Ped-Bike Adj(A_pbT)	1.00		1.00				1.00		1.00			
Parking Bus, Adj	1.00	1.00	1.00				1.00	1.00	1.00			
Adj Sat Flow, veh/h/ln	0	1810	0				0	1759	1759			
Adj Flow Rate, veh/h	0	348	0				0	1853	263			
Adj No. of Lanes	0	2	0				0	3	1			
Peak Hour Factor	0.90	0.90	0.90				0.90	0.90	0.90			
Percent Heavy Veh, %	0	5	0				0	8	8			
Cap, veh/h	0	550	0				0	3004	935			
Arrive On Green	0.00	0.16	0.00				0.00	0.63	0.63			
Sat Flow, veh/h	0	3619	0				0	4961	1495			
Grp Volume(v), veh/h	0	348	0				0	1853	263			
Grp Sat Flow(s),veh/h/ln	0	1719	0				0	1601	1495			
Q Serve(g_s), s	0.0	5.3	0.0				0.0	13.2	4.5			
Cycle Q Clear(g_c), s	0.0	5.3	0.0				0.0	13.2	4.5			
Prop In Lane	0.00		0.00				0.00		1.00			
Lane Grp Cap(c), veh/h	0	550	0				0	3004	935			
V/C Ratio(X)	0.00	0.63	0.00				0.00	0.62	0.28			
Avail Cap(c_a), veh/h	0	1044	0				0	4377	1363			
HCM Platoon Ratio	1.00	1.00	1.00				1.00	1.00	1.00			
Upstream Filter(I)	0.00	1.00	0.00				0.00	1.00	1.00			
Uniform Delay (d), s/veh	0.0	22.0	0.0				0.0	6.4	4.8			
Incr Delay (d2), s/veh	0.0	1.2	0.0				0.0	0.2	0.2			
Initial Q Delay(d3),s/veh	0.0	0.0	0.0				0.0	0.0	0.0			
%ile BackOfQ(50%),veh/ln	0.0	2.6	0.0				0.0	5.7	1.9			
LnGrp Delay(d),s/veh	0.0	23.2	0.0				0.0	6.6	4.9			
LnGrp LOS		C						A	A			
Approach Vol, veh/h		348						2116				
Approach Delay, s/veh		23.2						6.4				
Approach LOS		C						A				

Timer	1	2	3	4	5	6	7	8
Assigned Phs						6		8
Phs Duration (G+Y+Rc), s						41.0		15.0
Change Period (Y+Rc), s						6.0		6.0
Max Green Setting (Gmax), s						51.0		17.0
Max Q Clear Time (g_c+I1), s						15.2		7.3
Green Ext Time (p_c), s						19.8		1.5

Intersection Summary	
HCM 2010 Ctrl Delay	8.8
HCM 2010 LOS	A

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	0	145	53	0	0	0	50	0	0	0	1673	431
Number	7	4	14	3	8	18	1	6	16	5	2	12
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	0	1863	1863	0	1863	0	1696	0	0	0	1727	1727
Adj Flow Rate, veh/h	0	161	59	0	0	0	56	0	0	0	1859	479
Adj No. of Lanes	0	1	1	0	1	0	1	0	0	0	3	1
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Percent Heavy Veh, %	0	2	2	0	2	0	12	0	0	0	10	10
Cap, veh/h	0	215	183	0	215	0	106	0	0	0	3374	1050
Arrive On Green	0.00	0.12	0.12	0.00	0.00	0.00	0.07	0.00	0.00	0.00	0.72	0.72
Sat Flow, veh/h	0	1863	1583	0	1863	0	1616	56		0	4871	1468
Grp Volume(v), veh/h	0	161	59	0	0	0	56	55.5		0	1859	479
Grp Sat Flow(s),veh/h/ln	0	1863	1583	0	1863	0	1616	E		0	1572	1468
Q Serve(g_s), s	0.0	9.5	3.9	0.0	0.0	0.0	3.8			0.0	21.1	15.7
Cycle Q Clear(g_c), s	0.0	9.5	3.9	0.0	0.0	0.0	3.8			0.0	21.1	15.7
Prop In Lane	0.00		1.00	0.00		0.00	1.00			0.00		1.00
Lane Grp Cap(c), veh/h	0	215	183	0	215	0	106			0	3374	1050
V/C Ratio(X)	0.00	0.75	0.32	0.00	0.00	0.00	0.53			0.00	0.55	0.46
Avail Cap(c_a), veh/h	0	344	292	0	344	0	170			0	3374	1050
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00			1.00	1.00	1.00
Upstream Filter(I)	0.00	1.00	1.00	0.00	0.00	0.00	1.00			0.00	1.00	1.00
Uniform Delay (d), s/veh	0.0	48.7	46.3	0.0	0.0	0.0	51.5			0.0	7.6	6.8
Incr Delay (d2), s/veh	0.0	5.2	1.0	0.0	0.0	0.0	4.0			0.0	0.7	1.4
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0			0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	0.0	5.2	1.8	0.0	0.0	0.0	1.8			0.0	9.2	6.7
LnGrp Delay(d),s/veh	0.0	53.9	47.3	0.0	0.0	0.0	55.5			0.0	8.3	8.3
LnGrp LOS		D	D				E				A	A
Approach Vol, veh/h		220			0						2338	
Approach Delay, s/veh		52.1			0.0						8.3	
Approach LOS		D									A	

Timer	1	2	3	4	5	6	7	8
Assigned Phs	1	2		4				8
Phs Duration (G+Y+Rc), s	13.5	87.4		19.1				19.1
Change Period (Y+Rc), s	6.0	6.0		6.0				6.0
Max Green Setting (Gmax), s	12.0	69.0		21.0				21.0
Max Q Clear Time (g_c+I1), s	5.8	23.1		12.5				0.0
Green Ext Time (p_c), s	0.0	24.7		0.6				0.0

Intersection Summary	
HCM 2010 Ctrl Delay	13.0
HCM 2010 LOS	B

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	0	337	63	0	0	0	65	0	0	0	1019	217
Number	7	4	14	3	8	18	1	6	16	5	2	12
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	0	1863	1863	0	1863	0	1727	0	0	0	1759	1759
Adj Flow Rate, veh/h	0	374	70	0	0	0	72	0	0	0	1132	241
Adj No. of Lanes	0	1	1	0	1	0	1	0	0	0	3	1
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Percent Heavy Veh, %	0	2	2	0	2	0	10	0	0	0	8	8
Cap, veh/h	0	446	379	0	446	0	120	0	0	0	2990	931
Arrive On Green	0.00	0.24	0.24	0.00	0.00	0.00	0.07	0.00	0.00	0.00	0.62	0.62
Sat Flow, veh/h	0	1863	1583	0	1863	0	1645	72		0	4961	1495
Grp Volume(v), veh/h	0	374	70	0	0	0	72	53.7		0	1132	241
Grp Sat Flow(s),veh/h/ln	0	1863	1583	0	1863	0	1645	D		0	1601	1495
Q Serve(g_s), s	0.0	20.8	3.8	0.0	0.0	0.0	4.6			0.0	12.7	7.9
Cycle Q Clear(g_c), s	0.0	20.8	3.8	0.0	0.0	0.0	4.6			0.0	12.7	7.9
Prop In Lane	0.00		1.00	0.00		0.00	1.00			0.00		1.00
Lane Grp Cap(c), veh/h	0	446	379	0	446	0	120			0	2990	931
V/C Ratio(X)	0.00	0.84	0.18	0.00	0.00	0.00	0.60			0.00	0.38	0.26
Avail Cap(c_a), veh/h	0	734	624	0	734	0	196			0	2990	931
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00			1.00	1.00	1.00
Upstream Filter(I)	0.00	1.00	1.00	0.00	0.00	0.00	1.00			0.00	1.00	1.00
Uniform Delay (d), s/veh	0.0	39.4	33.0	0.0	0.0	0.0	49.0			0.0	10.2	9.3
Incr Delay (d2), s/veh	0.0	4.5	0.2	0.0	0.0	0.0	4.7			0.0	0.4	0.7
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0			0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	0.0	11.3	1.7	0.0	0.0	0.0	2.3			0.0	5.7	3.4
LnGrp Delay(d),s/veh	0.0	44.0	33.2	0.0	0.0	0.0	53.7			0.0	10.5	9.9
LnGrp LOS		D	C				D				B	A
Approach Vol, veh/h		444			0						1373	
Approach Delay, s/veh		42.3			0.0						10.4	
Approach LOS		D									B	

Timer	1	2	3	4	5	6	7	8
Assigned Phs	1	2		4				8
Phs Duration (G+Y+Rc), s	14.0	73.9		32.1				32.1
Change Period (Y+Rc), s	6.0	6.0		6.0				6.0
Max Green Setting (Gmax), s	13.0	46.0		43.0				43.0
Max Q Clear Time (g_c+I1), s	6.6	14.7		23.8				0.0
Green Ext Time (p_c), s	0.1	9.9		2.3				0.0

Intersection Summary	
HCM 2010 Ctrl Delay	19.6
HCM 2010 LOS	B

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	0	0	0	0	23	318	0	611	96	141	0	0
Number	7	4	14	3	8	18	1	6	16	5	2	12
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	0	1863	0	0	1696	1696	0	1712	1900	1696	0	0
Adj Flow Rate, veh/h	0	0	0	0	26	353	0	679	107	157	0	0
Adj No. of Lanes	0	1	0	0	1	1	0	3	0	1	0	0
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Percent Heavy Veh, %	0	2	0	0	12	12	0	11	11	12	0	0
Cap, veh/h	0	274	0	0	249	951	0	2090	326	195	0	0
Arrive On Green	0.00	0.00	0.00	0.00	0.15	0.15	0.00	0.51	0.51	0.12	0.00	0.00
Sat Flow, veh/h	0	1863	0	0	1696	1442	0	4233	636	1616	157	
Grp Volume(v), veh/h	0	0	0	0	26	353	0	517	269	157	42.6	
Grp Sat Flow(s),veh/h/ln	0	1863	0	0	1696	1442	0	1558	1599	1616	D	
Q Serve(g_s), s	0.0	0.0	0.0	0.0	1.1	9.0	0.0	7.9	8.1	7.8		
Cycle Q Clear(g_c), s	0.0	0.0	0.0	0.0	1.1	9.0	0.0	7.9	8.1	7.8		
Prop In Lane	0.00		0.00	0.00		1.00	0.00		0.40	1.00		
Lane Grp Cap(c), veh/h	0	274	0	0	249	951	0	1597	820	195		
V/C Ratio(X)	0.00	0.00	0.00	0.00	0.10	0.37	0.00	0.32	0.33	0.80		
Avail Cap(c_a), veh/h	0	455	0	0	414	1091	0	1597	820	789		
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00		
Upstream Filter(I)	0.00	0.00	0.00	0.00	1.00	1.00	0.00	1.00	1.00	1.00		
Uniform Delay (d), s/veh	0.0	0.0	0.0	0.0	30.3	6.3	0.0	11.7	11.7	35.1		
Incr Delay (d2), s/veh	0.0	0.0	0.0	0.0	0.2	0.2	0.0	0.5	1.1	7.5		
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		
%ile BackOfQ(50%),veh/ln	0.0	0.0	0.0	0.0	0.5	8.0	0.0	3.5	3.8	3.9		
LnGrp Delay(d),s/veh	0.0	0.0	0.0	0.0	30.5	6.5	0.0	12.2	12.8	42.6		
LnGrp LOS					C	A		B	B	D		
Approach Vol, veh/h		0			379			786				
Approach Delay, s/veh		0.0			8.2			12.4				
Approach LOS					A			B				

Timer	1	2	3	4	5	6	7	8
Assigned Phs				4	5	6		8
Phs Duration (G+Y+Rc), s				18.0	15.9	48.0		18.0
Change Period (Y+Rc), s				6.0	6.0	6.0		6.0
Max Green Setting (Gmax), s				20.0	40.0	42.0		20.0
Max Q Clear Time (g_c+I1), s				0.0	9.8	10.1		11.0
Green Ext Time (p_c), s				0.0	0.4	5.2		1.0

Intersection Summary	
HCM 2010 Ctrl Delay	14.8
HCM 2010 LOS	B

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	0	0	0	0	4	391	0	1202	126	82	0	0
Number	7	4	14	3	8	18	1	6	16	5	2	12
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	0	1863	0	0	1727	1727	0	1743	1900	1727	0	0
Adj Flow Rate, veh/h	0	0	0	0	4	434	0	1336	140	91	0	0
Adj No. of Lanes	0	1	0	0	1	1	0	3	0	1	0	0
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Percent Heavy Veh, %	0	2	0	0	10	10	0	9	9	10	0	0
Cap, veh/h	0	281	0	0	260	1041	0	2443	256	148	0	0
Arrive On Green	0.00	0.00	0.00	0.00	0.15	0.15	0.00	0.56	0.56	0.09	0.00	0.00
Sat Flow, veh/h	0	1863	0	0	1727	1468	0	4533	459	1645	91	
Grp Volume(v), veh/h	0	0	0	0	4	434	0	969	507	91	43.3	
Grp Sat Flow(s),veh/h/ln	0	1863	0	0	1727	1468	0	1586	1662	1645	D	
Q Serve(g_s), s	0.0	0.0	0.0	0.0	0.2	10.9	0.0	17.4	17.4	4.8		
Cycle Q Clear(g_c), s	0.0	0.0	0.0	0.0	0.2	10.9	0.0	17.4	17.4	4.8		
Prop In Lane	0.00		0.00	0.00		1.00	0.00		0.28	1.00		
Lane Grp Cap(c), veh/h	0	281	0	0	260	1041	0	1771	928	148		
V/C Ratio(X)	0.00	0.00	0.00	0.00	0.02	0.42	0.00	0.55	0.55	0.61		
Avail Cap(c_a), veh/h	0	333	0	0	309	1082	0	1771	928	661		
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00		
Upstream Filter(I)	0.00	0.00	0.00	0.00	1.00	1.00	0.00	1.00	1.00	1.00		
Uniform Delay (d), s/veh	0.0	0.0	0.0	0.0	32.4	5.4	0.0	12.6	12.6	39.2		
Incr Delay (d2), s/veh	0.0	0.0	0.0	0.0	0.0	0.3	0.0	1.2	2.3	4.1		
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		
%ile BackOfQ(50%),veh/ln	0.0	0.0	0.0	0.0	0.1	10.7	0.0	7.8	8.5	2.3		
LnGrp Delay(d),s/veh	0.0	0.0	0.0	0.0	32.4	5.7	0.0	13.8	14.9	43.3		
LnGrp LOS					C	A		B	B	D		
Approach Vol, veh/h		0			438			1476				
Approach Delay, s/veh		0.0			5.9			14.2				
Approach LOS					A			B				

Timer	1	2	3	4	5	6	7	8
Assigned Phs				4	5	6		8
Phs Duration (G+Y+Rc), s				19.5	14.1	56.0		19.5
Change Period (Y+Rc), s				6.0	6.0	6.0		6.0
Max Green Setting (Gmax), s				16.0	36.0	50.0		16.0
Max Q Clear Time (g_c+I1), s				0.0	6.8	19.4		12.9
Green Ext Time (p_c), s				0.0	0.2	11.7		0.6

Intersection Summary	
HCM 2010 Ctrl Delay	13.7
HCM 2010 LOS	B

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	0	0	0	0	273	70	0	702	95	132	0	0
Number	7	4	14	3	8	18	1	6	16	5	2	12
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	0	1863	0	0	1792	1792	0	1712	1712	1712	0	0
Adj Flow Rate, veh/h	0	0	0	0	303	78	0	780	106	147	0	0
Adj No. of Lanes	0	1	0	0	1	1	0	3	1	1	0	0
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Percent Heavy Veh, %	0	2	0	0	6	6	0	11	11	11	0	0
Cap, veh/h	0	395	0	0	380	1016	0	2124	661	183	0	0
Arrive On Green	0.00	0.00	0.00	0.00	0.21	0.21	0.00	0.45	0.45	0.11	0.00	0.00
Sat Flow, veh/h	0	1863	0	0	1792	1524	0	4827	1455	1630	147	
Grp Volume(v), veh/h	0	0	0	0	303	78	0	780	106	147	43.2	
Grp Sat Flow(s),veh/h/ln	0	1863	0	0	1792	1524	0	1558	1455	1630	D	
Q Serve(g_s), s	0.0	0.0	0.0	0.0	13.0	1.5	0.0	8.9	3.5	7.2		
Cycle Q Clear(g_c), s	0.0	0.0	0.0	0.0	13.0	1.5	0.0	8.9	3.5	7.2		
Prop In Lane	0.00		0.00	0.00		1.00	0.00		1.00	1.00		
Lane Grp Cap(c), veh/h	0	395	0	0	380	1016	0	2124	661	183		
V/C Ratio(X)	0.00	0.00	0.00	0.00	0.80	0.08	0.00	0.37	0.16	0.80		
Avail Cap(c_a), veh/h	0	915	0	0	881	1441	0	2124	661	501		
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00		
Upstream Filter(I)	0.00	0.00	0.00	0.00	0.97	0.97	0.00	1.00	1.00	1.00		
Uniform Delay (d), s/veh	0.0	0.0	0.0	0.0	30.4	4.8	0.0	14.5	13.1	35.2		
Incr Delay (d2), s/veh	0.0	0.0	0.0	0.0	3.8	0.0	0.0	0.5	0.5	7.9		
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		
%ile BackOfQ(50%),veh/ln	0.0	0.0	0.0	0.0	6.9	1.5	0.0	3.9	1.5	3.6		
LnGrp Delay(d),s/veh	0.0	0.0	0.0	0.0	34.2	4.8	0.0	15.0	13.6	43.2		
LnGrp LOS					C	A		B	B	D		
Approach Vol, veh/h		0			381			886				
Approach Delay, s/veh		0.0			28.2			14.9				
Approach LOS					C			B				

Timer	1	2	3	4	5	6	7	8
Assigned Phs				4	5	6		8
Phs Duration (G+Y+Rc), s				23.3	15.1	43.0		23.3
Change Period (Y+Rc), s				6.0	6.0	6.0		6.0
Max Green Setting (Gmax), s				40.0	25.0	37.0		40.0
Max Q Clear Time (g_c+I1), s				0.0	9.2	10.9		15.0
Green Ext Time (p_c), s				0.0	0.3	5.7		2.2

Intersection Summary	
HCM 2010 Ctrl Delay	21.4
HCM 2010 LOS	C

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	0	0	0	0	193	109	0	1198	158	98	0	0
Number	7	4	14	3	8	18	1	6	16	5	2	12
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	0	1863	0	0	1827	1827	0	1743	1743	1743	0	0
Adj Flow Rate, veh/h	0	0	0	0	214	121	0	1331	176	109	0	0
Adj No. of Lanes	0	1	0	0	1	1	0	3	1	1	0	0
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Percent Heavy Veh, %	0	2	0	0	4	4	0	9	9	9	0	0
Cap, veh/h	0	279	0	0	274	1118	0	2714	845	149	0	0
Arrive On Green	0.00	0.00	0.00	0.00	0.15	0.15	0.00	0.57	0.57	0.09	0.00	0.00
Sat Flow, veh/h	0	1863	0	0	1827	1553	0	4916	1482	1660	109	
Grp Volume(v), veh/h	0	0	0	0	214	121	0	1331	176	109	48.8	
Grp Sat Flow(s),veh/h/ln	0	1863	0	0	1827	1553	0	1586	1482	1660	D	
Q Serve(g_s), s	0.0	0.0	0.0	0.0	10.7	2.2	0.0	15.8	5.5	6.1		
Cycle Q Clear(g_c), s	0.0	0.0	0.0	0.0	10.7	2.2	0.0	15.8	5.5	6.1		
Prop In Lane	0.00		0.00	0.00		1.00	0.00		1.00	1.00		
Lane Grp Cap(c), veh/h	0	279	0	0	274	1118	0	2714	845	149		
V/C Ratio(X)	0.00	0.00	0.00	0.00	0.78	0.11	0.00	0.49	0.21	0.73		
Avail Cap(c_a), veh/h	0	571	0	0	560	1361	0	2714	845	333		
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00		
Upstream Filter(I)	0.00	0.00	0.00	0.00	0.95	0.95	0.00	1.00	1.00	1.00		
Uniform Delay (d), s/veh	0.0	0.0	0.0	0.0	38.8	4.0	0.0	12.1	9.9	42.0		
Incr Delay (d2), s/veh	0.0	0.0	0.0	0.0	4.6	0.0	0.0	0.6	0.6	6.8		
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0		
%ile BackOfQ(50%),veh/ln	0.0	0.0	0.0	0.0	5.8	2.9	0.0	7.1	2.4	3.1		
LnGrp Delay(d),s/veh	0.0	0.0	0.0	0.0	43.4	4.1	0.0	12.8	10.5	48.8		
LnGrp LOS					D	A		B	B	D		
Approach Vol, veh/h		0			335			1507				
Approach Delay, s/veh		0.0			29.2			12.5				
Approach LOS					C			B				

Timer	1	2	3	4	5	6	7	8
Assigned Phs				4	5	6		8
Phs Duration (G+Y+Rc), s				20.2	14.5	60.0		20.2
Change Period (Y+Rc), s				6.0	6.0	6.0		6.0
Max Green Setting (Gmax), s				29.0	19.0	54.0		29.0
Max Q Clear Time (g_c+I1), s				0.0	8.1	17.8		12.7
Green Ext Time (p_c), s				0.0	0.2	12.3		1.5

Intersection Summary	
HCM 2010 Ctrl Delay	17.4
HCM 2010 LOS	B

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Volume (veh/h)	111	33	74	714	1236	212
Number	3	18	1	6	2	12
Initial Q (Qb), veh	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00	1.00	1.00			1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1310	1310	1759	1759	1712	1712
Adj Flow Rate, veh/h	123	37	82	793	1373	236
Adj No. of Lanes	2	1	1	3	3	1
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90
Percent Heavy Veh, %	45	45	8	8	11	11
Cap, veh/h	339	156	276	3189	3103	966
Arrive On Green	0.14	0.14	1.00	1.00	0.66	0.66
Sat Flow, veh/h	2421	1114	296	4961	4827	1455
Grp Volume(v), veh/h	123	37	82	793	1373	236
Grp Sat Flow(s),veh/h/ln	1211	1114	296	1601	1558	1455
Q Serve(g_s), s	2.7	1.8	6.0	0.0	8.3	3.9
Cycle Q Clear(g_c), s	2.7	1.8	14.3	0.0	8.3	3.9
Prop In Lane	1.00	1.00	1.00			1.00
Lane Grp Cap(c), veh/h	339	156	276	3189	3103	966
V/C Ratio(X)	0.36	0.24	0.30	0.25	0.44	0.24
Avail Cap(c_a), veh/h	365	168	276	3189	3103	966
HCM Platoon Ratio	1.00	1.00	2.00	2.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	0.88	0.88	1.00	1.00
Uniform Delay (d), s/veh	23.2	22.8	1.5	0.0	4.8	4.0
Incr Delay (d2), s/veh	0.7	0.8	2.4	0.2	0.5	0.6
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	1.0	0.6	0.6	0.0	3.7	1.7
LnGrp Delay(d),s/veh	23.9	23.6	3.9	0.2	5.2	4.6
LnGrp LOS	C	C	A	A	A	A
Approach Vol, veh/h	160			875	1609	
Approach Delay, s/veh	23.8			0.5	5.1	
Approach LOS	C			A	A	

Timer	1	2	3	4	5	6	7	8
Assigned Phs		2				6		8
Phs Duration (G+Y+Rc), s		45.6				45.6		14.4
Change Period (Y+Rc), s		6.0				6.0		6.0
Max Green Setting (Gmax), s		39.0				39.0		9.0
Max Q Clear Time (g_c+I1), s		10.3				16.3		4.7
Green Ext Time (p_c), s		20.9				17.5		0.2

Intersection Summary	
HCM 2010 Ctrl Delay	4.7
HCM 2010 LOS	A

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Volume (veh/h)	204	58	42	1211	788	134
Number	3	18	1	6	2	12
Initial Q (Qb), veh	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00	1.00	1.00			1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1387	1387	1776	1776	1743	1743
Adj Flow Rate, veh/h	227	64	47	1346	876	149
Adj No. of Lanes	2	1	1	3	3	1
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90
Percent Heavy Veh, %	37	37	7	7	9	9
Cap, veh/h	398	183	443	3298	3237	1008
Arrive On Green	0.16	0.16	0.68	0.68	0.68	0.68
Sat Flow, veh/h	2562	1179	522	5007	4916	1482
Grp Volume(v), veh/h	227	64	47	1346	876	149
Grp Sat Flow(s),veh/h/ln	1281	1179	522	1616	1586	1482
Q Serve(g_s), s	4.7	2.8	2.2	7.1	4.1	2.1
Cycle Q Clear(g_c), s	4.7	2.8	6.4	7.1	4.1	2.1
Prop In Lane	1.00	1.00	1.00			1.00
Lane Grp Cap(c), veh/h	398	183	443	3298	3237	1008
V/C Ratio(X)	0.57	0.35	0.11	0.41	0.27	0.15
Avail Cap(c_a), veh/h	624	287	443	3298	3237	1008
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	0.76	0.76	1.00	1.00
Uniform Delay (d), s/veh	22.5	21.7	4.8	4.1	3.6	3.3
Incr Delay (d2), s/veh	1.3	1.1	0.4	0.3	0.2	0.3
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	1.7	1.0	0.4	3.2	1.8	0.9
LnGrp Delay(d),s/veh	23.8	22.8	5.2	4.4	3.8	3.6
LnGrp LOS	C	C	A	A	A	A
Approach Vol, veh/h	291			1393	1025	
Approach Delay, s/veh	23.6			4.4	3.8	
Approach LOS	C			A	A	

Timer	1	2	3	4	5	6	7	8
Assigned Phs		2				6		8
Phs Duration (G+Y+Rc), s		45.1				45.1		14.9
Change Period (Y+Rc), s		6.0				6.0		6.0
Max Green Setting (Gmax), s		34.0				34.0		14.0
Max Q Clear Time (g_c+I1), s		6.1				9.1		6.7
Green Ext Time (p_c), s		19.2				17.8		0.6

Intersection Summary	
HCM 2010 Ctrl Delay	6.2
HCM 2010 LOS	A

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	104	85	7	145	111	144	26	598	218	182	872	225
Number	3	8	18	7	4	14	1	6	16	5	2	12
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1776	1776	1900	1863	1863	1863	1900	1776	1900	1759	1759	1759
Adj Flow Rate, veh/h	116	94	8	161	123	160	29	664	242	202	969	250
Adj No. of Lanes	1	1	0	1	1	1	0	3	0	1	2	1
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Percent Heavy Veh, %	7	7	7	2	2	2	7	7	7	8	8	8
Cap, veh/h	291	457	39	262	288	245	79	1676	598	425	2199	1098
Arrive On Green	0.08	0.28	0.28	0.15	0.15	0.15	0.53	0.53	0.53	0.16	1.00	1.00
Sat Flow, veh/h	1691	1614	137	1287	1863	1583	85	3180	1135	1675	3343	1495
Grp Volume(v), veh/h	116	0	102	161	123	160	325	309	302	202	969	250
Grp Sat Flow(s),veh/h/ln	1691	0	1751	1287	1863	1583	1514	1470	1416	1675	1671	1495
Q Serve(g_s), s	6.4	0.0	5.1	13.9	6.9	10.9	0.0	14.4	14.7	6.3	0.0	0.0
Cycle Q Clear(g_c), s	6.4	0.0	5.1	13.9	6.9	10.9	12.1	14.4	14.7	6.3	0.0	0.0
Prop In Lane	1.00		0.08	1.00		1.00	0.09		0.80	1.00		1.00
Lane Grp Cap(c), veh/h	291	0	496	262	288	245	832	775	746	425	2199	1098
V/C Ratio(X)	0.40	0.00	0.21	0.62	0.43	0.65	0.39	0.40	0.40	0.48	0.44	0.23
Avail Cap(c_a), veh/h	294	0	656	377	455	386	832	775	746	527	2199	1098
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	2.00	2.00	2.00
Upstream Filter(I)	1.00	0.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.92	0.92	0.92
Uniform Delay (d), s/veh	35.2	0.0	31.3	46.9	43.9	45.6	15.7	16.2	16.3	10.2	0.0	0.0
Incr Delay (d2), s/veh	0.9	0.0	0.2	2.3	1.0	2.9	1.4	1.5	1.6	0.8	0.6	0.4
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	3.0	0.0	2.5	5.1	3.6	5.0	6.3	6.2	6.0	2.9	0.2	0.1
LnGrp Delay(d),s/veh	36.1	0.0	31.5	49.2	44.9	48.6	17.1	17.8	17.9	10.9	0.6	0.4
LnGrp LOS	D		C	D	D	D	B	B	B	B	A	A
Approach Vol, veh/h		218			444			935			1421	
Approach Delay, s/veh		33.9			47.8			17.6			2.0	
Approach LOS		C			D			B			A	

Timer	1	2	3	4	5	6	7	8
Assigned Phs		2	3	4	5	6		8
Phs Duration (G+Y+Rc), s		81.5	14.8	23.7	15.0	66.5		38.5
Change Period (Y+Rc), s		6.0	6.0	6.0	6.0	6.0		6.0
Max Green Setting (Gmax), s		65.0	9.0	28.0	16.0	43.0		43.0
Max Q Clear Time (g_c+I1), s		2.0	8.4	15.9	8.3	16.7		7.1
Green Ext Time (p_c), s		25.3	0.0	1.9	0.3	16.5		2.4

Intersection Summary	
HCM 2010 Ctrl Delay	15.9
HCM 2010 LOS	B

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	163	155	10	139	73	164	9	942	239	136	597	170
Number	3	8	18	7	4	14	1	6	16	5	2	12
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1792	1792	1900	1863	1863	1863	1900	1810	1900	1776	1776	1776
Adj Flow Rate, veh/h	181	172	11	154	81	182	10	1047	266	151	663	189
Adj No. of Lanes	1	1	0	1	1	1	0	3	0	1	2	1
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Percent Heavy Veh, %	6	6	6	2	2	2	5	5	5	7	7	7
Cap, veh/h	337	493	32	251	295	250	38	1914	483	318	2138	1086
Arrive On Green	0.09	0.30	0.30	0.16	0.16	0.16	0.50	0.50	0.50	0.15	1.00	1.00
Sat Flow, veh/h	1707	1667	107	1196	1863	1583	13	3792	957	1691	3374	1509
Grp Volume(v), veh/h	181	0	183	154	81	182	496	416	411	151	663	189
Grp Sat Flow(s),veh/h/ln	1707	0	1774	1196	1863	1583	1786	1498	1478	1691	1687	1509
Q Serve(g_s), s	10.0	0.0	9.4	14.5	4.4	12.7	0.0	22.1	22.2	4.6	0.0	0.0
Cycle Q Clear(g_c), s	10.0	0.0	9.4	14.5	4.4	12.7	21.8	22.1	22.2	4.6	0.0	0.0
Prop In Lane	1.00		0.06	1.00		1.00	0.02		0.65	1.00		1.00
Lane Grp Cap(c), veh/h	337	0	525	251	295	250	933	756	746	318	2138	1086
V/C Ratio(X)	0.54	0.00	0.35	0.61	0.27	0.73	0.53	0.55	0.55	0.48	0.31	0.17
Avail Cap(c_a), veh/h	337	0	641	330	417	354	933	756	746	376	2138	1086
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	2.00	2.00	2.00
Upstream Filter(I)	1.00	0.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.97	0.97	0.97
Uniform Delay (d), s/veh	35.8	0.0	32.1	47.3	43.0	46.5	19.6	19.7	19.7	12.9	0.0	0.0
Incr Delay (d2), s/veh	1.7	0.0	0.4	2.4	0.5	4.4	2.2	2.9	2.9	1.1	0.4	0.3
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	0.6	0.0	4.7	5.0	2.3	5.9	11.3	9.7	9.6	2.2	0.1	0.1
LnGrp Delay(d),s/veh	37.4	0.0	32.5	49.7	43.5	50.9	21.8	22.6	22.7	14.0	0.4	0.3
LnGrp LOS	D		C	D	D	D	C	C	C	B	A	A
Approach Vol, veh/h		364			417			1323			1003	
Approach Delay, s/veh		35.0			49.0			22.3			2.4	
Approach LOS		C			D			C			A	

Timer	1	2	3	4	5	6	7	8
Assigned Phs		2	3	4	5	6		8
Phs Duration (G+Y+Rc), s		79.6	16.0	24.4	15.0	64.6		40.4
Change Period (Y+Rc), s		6.0	6.0	6.0	6.0	6.0		6.0
Max Green Setting (Gmax), s		66.0	10.0	26.0	13.0	47.0		42.0
Max Q Clear Time (g_c+I1), s		2.0	12.0	16.5	6.6	24.2		11.4
Green Ext Time (p_c), s		25.0	0.0	1.9	0.2	14.9		2.8

Intersection Summary	
HCM 2010 Ctrl Delay	21.0
HCM 2010 LOS	C

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	7	16	32	110	15	24	14	817	39	21	992	8
Number	3	8	18	7	4	14	1	6	16	5	2	12
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1900	1863	1900	1900	1845	1900	1792	1792	1900	1776	1776	1900
Adj Flow Rate, veh/h	8	18	36	122	17	27	16	908	43	23	1102	9
Adj No. of Lanes	0	1	0	0	1	0	1	2	0	1	2	0
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Percent Heavy Veh, %	2	2	2	3	3	3	6	6	6	7	7	7
Cap, veh/h	86	149	236	344	51	58	289	1879	89	339	1946	16
Arrive On Green	0.25	0.25	0.25	0.25	0.25	0.25	0.57	0.57	0.57	0.57	0.57	0.57
Sat Flow, veh/h	90	606	963	1005	209	236	486	3311	157	560	3430	28
Grp Volume(v), veh/h	62	0	0	166	0	0	16	467	484	23	542	569
Grp Sat Flow(s),veh/h/ln	1659	0	0	1450	0	0	486	1703	1765	560	1687	1771
Q Serve(g_s), s	0.0	0.0	0.0	4.1	0.0	0.0	1.4	10.5	10.5	1.6	13.1	13.1
Cycle Q Clear(g_c), s	1.8	0.0	0.0	5.9	0.0	0.0	14.5	10.5	10.5	12.1	13.1	13.1
Prop In Lane	0.13		0.58	0.73		0.16	1.00		0.09	1.00		0.02
Lane Grp Cap(c), veh/h	470	0	0	453	0	0	289	966	1001	339	957	1005
V/C Ratio(X)	0.13	0.00	0.00	0.37	0.00	0.00	0.06	0.48	0.48	0.07	0.57	0.57
Avail Cap(c_a), veh/h	705	0	0	657	0	0	415	1408	1459	484	1395	1464
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	0.00	0.00	1.00	0.00	0.00	1.00	1.00	1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	18.9	0.0	0.0	20.3	0.0	0.0	13.5	8.3	8.3	11.9	8.8	8.8
Incr Delay (d2), s/veh	0.1	0.0	0.0	0.5	0.0	0.0	0.1	0.4	0.4	0.1	0.5	0.5
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	0.9	0.0	0.0	2.6	0.0	0.0	0.2	4.9	5.1	0.3	6.2	6.5
LnGrp Delay(d),s/veh	19.1	0.0	0.0	20.8	0.0	0.0	13.5	8.6	8.6	12.0	9.4	9.3
LnGrp LOS	B			C			B	A	A	B	A	A
Approach Vol, veh/h		62			166			967			1134	
Approach Delay, s/veh		19.1			20.8			8.7			9.4	
Approach LOS		B			C			A			A	

Timer	1	2	3	4	5	6	7	8
Assigned Phs		2		4		6		8
Phs Duration (G+Y+Rc), s		42.4		21.7		42.4		21.7
Change Period (Y+Rc), s		6.0		6.0		6.0		6.0
Max Green Setting (Gmax), s		53.0		25.0		53.0		25.0
Max Q Clear Time (g_c+I1), s		15.1		7.9		16.5		3.8
Green Ext Time (p_c), s		20.2		1.2		19.9		1.3

Intersection Summary	
HCM 2010 Ctrl Delay	10.2
HCM 2010 LOS	B

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	6	13	16	63	26	30	29	1092	80	26	741	11
Number	3	8	18	7	4	14	1	6	16	5	2	12
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1900	1863	1900	1900	1845	1900	1792	1792	1900	1810	1810	1900
Adj Flow Rate, veh/h	7	14	18	70	29	33	32	1213	89	29	823	12
Adj No. of Lanes	0	1	0	0	1	0	1	2	0	1	2	0
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Percent Heavy Veh, %	2	2	2	3	3	3	6	6	6	5	5	5
Cap, veh/h	94	162	168	231	96	83	412	1971	144	256	2125	31
Arrive On Green	0.22	0.22	0.22	0.22	0.22	0.22	0.61	0.61	0.61	0.61	0.61	0.61
Sat Flow, veh/h	156	741	769	702	442	381	630	3218	236	409	3469	51
Grp Volume(v), veh/h	39	0	0	132	0	0	32	641	661	29	408	427
Grp Sat Flow(s),veh/h/ln	1666	0	0	1526	0	0	630	1703	1751	409	1719	1801
Q Serve(g_s), s	0.0	0.0	0.0	3.2	0.0	0.0	1.9	16.6	16.6	3.4	8.5	8.5
Cycle Q Clear(g_c), s	1.3	0.0	0.0	5.0	0.0	0.0	10.5	16.6	16.6	20.0	8.5	8.5
Prop In Lane	0.18		0.46	0.53		0.25	1.00		0.13	1.00		0.03
Lane Grp Cap(c), veh/h	423	0	0	411	0	0	412	1043	1072	256	1053	1103
V/C Ratio(X)	0.09	0.00	0.00	0.32	0.00	0.00	0.08	0.61	0.62	0.11	0.39	0.39
Avail Cap(c_a), veh/h	527	0	0	507	0	0	542	1394	1434	341	1408	1474
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	0.00	0.00	1.00	0.00	0.00	1.00	1.00	1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	22.2	0.0	0.0	23.5	0.0	0.0	9.6	8.5	8.5	14.8	7.0	7.0
Incr Delay (d2), s/veh	0.1	0.0	0.0	0.4	0.0	0.0	0.1	0.6	0.6	0.2	0.2	0.2
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	0.6	0.0	0.0	2.3	0.0	0.0	0.3	7.8	8.1	0.4	4.0	4.2
LnGrp Delay(d),s/veh	22.3	0.0	0.0	24.0	0.0	0.0	9.7	9.1	9.1	15.0	7.2	7.2
LnGrp LOS	C			C			A	A	A	B	A	A
Approach Vol, veh/h		39			132			1334			864	
Approach Delay, s/veh		22.3			24.0			9.1			7.5	
Approach LOS		C			C			A			A	

Timer	1	2	3	4	5	6	7	8
Assigned Phs		2		4		6		8
Phs Duration (G+Y+Rc), s		49.4		21.4		49.4		21.4
Change Period (Y+Rc), s		6.0		6.0		6.0		6.0
Max Green Setting (Gmax), s		58.0		20.0		58.0		20.0
Max Q Clear Time (g_c+I1), s		22.0		7.0		18.6		3.3
Green Ext Time (p_c), s		21.4		0.7		22.5		0.8

Intersection Summary	
HCM 2010 Ctrl Delay	9.6
HCM 2010 LOS	A

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	41	64	18	134	89	215	16	655	292	332	888	50
Number	3	8	18	7	4	14	1	6	16	5	2	12
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1900	1792	1900	1900	1792	1792	1810	1810	1810	1792	1792	1792
Adj Flow Rate, veh/h	46	71	20	149	99	239	18	728	324	369	987	56
Adj No. of Lanes	0	2	0	0	1	1	1	2	1	1	2	1
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Percent Heavy Veh, %	6	6	6	6	6	6	5	5	5	6	6	6
Cap, veh/h	125	341	98	244	133	421	300	1603	717	506	2192	981
Arrive On Green	0.28	0.28	0.28	0.28	0.28	0.28	0.93	0.93	0.93	0.13	0.64	0.64
Sat Flow, veh/h	253	1232	353	721	479	1524	523	3438	1538	1707	3406	1524
Grp Volume(v), veh/h	48	0	89	248	0	239	18	728	324	369	987	56
Grp Sat Flow(s),veh/h/ln	269	0	1569	1201	0	1524	523	1719	1538	1707	1703	1524
Q Serve(g_s), s	5.7	0.0	5.6	20.8	0.0	17.3	0.3	3.2	3.1	13.7	18.6	1.7
Cycle Q Clear(g_c), s	32.0	0.0	5.6	26.3	0.0	17.3	0.4	3.2	3.1	13.7	18.6	1.7
Prop In Lane	0.96		0.22	0.60		1.00	1.00		1.00	1.00		1.00
Lane Grp Cap(c), veh/h	129	0	434	377	0	421	300	1603	717	506	2192	981
V/C Ratio(X)	0.37	0.00	0.21	0.66	0.00	0.57	0.06	0.45	0.45	0.73	0.45	0.06
Avail Cap(c_a), veh/h	158	0	477	416	0	463	300	1603	717	709	2192	981
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	2.00	2.00	2.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	0.00	1.00	0.93	0.00	0.93	0.91	0.91	0.91	0.71	0.71	0.71
Uniform Delay (d), s/veh	57.1	0.0	35.6	45.6	0.0	39.8	2.3	2.4	2.4	12.7	11.5	8.4
Incr Delay (d2), s/veh	1.8	0.0	0.2	3.1	0.0	1.2	0.3	0.8	1.9	1.7	0.5	0.1
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	1.7	0.0	2.4	8.4	0.0	7.4	0.1	1.4	1.4	6.6	8.8	0.8
LnGrp Delay(d),s/veh	58.9	0.0	35.8	48.7	0.0	41.0	2.7	3.3	4.3	14.3	11.9	8.5
LnGrp LOS	E		D	D		D	A	A	A	B	B	A
Approach Vol, veh/h		137			487			1070			1412	
Approach Delay, s/veh		43.9			44.9			3.6			12.4	
Approach LOS		D			D			A			B	

Timer	1	2	3	4	5	6	7	8
Assigned Phs		2		4	5	6		8
Phs Duration (G+Y+Rc), s		88.5		41.5	22.7	65.8		41.5
Change Period (Y+Rc), s		6.0		6.0	6.0	6.0		6.0
Max Green Setting (Gmax), s		79.0		39.0	32.0	41.0		39.0
Max Q Clear Time (g_c+I1), s		20.6		28.3	15.7	5.2		34.0
Green Ext Time (p_c), s		23.6		2.4	1.0	19.2		1.5

Intersection Summary	
HCM 2010 Ctrl Delay	15.9
HCM 2010 LOS	B

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	32	59	32	183	96	367	27	826	182	145	557	44
Number	3	8	18	7	4	14	1	6	16	5	2	12
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1900	1792	1900	1900	1810	1810	1810	1810	1810	1792	1792	1792
Adj Flow Rate, veh/h	36	66	36	203	107	408	30	918	202	161	619	49
Adj No. of Lanes	0	2	0	0	1	1	1	2	1	1	2	1
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Percent Heavy Veh, %	6	6	6	5	5	5	5	5	5	6	6	6
Cap, veh/h	111	327	193	306	137	501	420	1678	751	406	2065	924
Arrive On Green	0.33	0.33	0.33	0.33	0.33	0.33	0.98	0.98	0.98	0.07	0.61	0.61
Sat Flow, veh/h	184	1004	593	795	419	1538	744	3438	1538	1707	3406	1524
Grp Volume(v), veh/h	45	0	93	310	0	408	30	918	202	161	619	49
Grp Sat Flow(s),veh/h/ln	254	0	1526	1215	0	1538	744	1719	1538	1707	1703	1524
Q Serve(g_s), s	4.8	0.0	5.5	25.8	0.0	30.8	0.1	1.7	0.5	5.6	11.1	1.7
Cycle Q Clear(g_c), s	36.0	0.0	5.5	31.3	0.0	30.8	0.2	1.7	0.5	5.6	11.1	1.7
Prop In Lane	0.79		0.39	0.65		1.00	1.00		1.00	1.00		1.00
Lane Grp Cap(c), veh/h	134	0	497	443	0	501	420	1678	751	406	2065	924
V/C Ratio(X)	0.34	0.00	0.19	0.70	0.00	0.81	0.07	0.55	0.27	0.40	0.30	0.05
Avail Cap(c_a), veh/h	185	0	579	518	0	583	420	1678	751	460	2065	924
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	2.00	2.00	2.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	0.00	1.00	0.85	0.00	0.85	0.85	0.85	0.85	0.93	0.93	0.93
Uniform Delay (d), s/veh	50.4	0.0	30.6	41.8	0.0	39.2	0.8	0.8	0.8	12.7	12.0	10.1
Incr Delay (d2), s/veh	1.5	0.0	0.2	2.9	0.0	6.5	0.3	1.1	0.8	0.6	0.3	0.1
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	1.6	0.0	2.3	10.3	0.0	14.0	0.1	0.7	0.3	2.7	5.3	0.7
LnGrp Delay(d),s/veh	51.9	0.0	30.8	44.7	0.0	45.7	1.1	1.9	1.5	13.3	12.3	10.2
LnGrp LOS	D		C	D		D	A	A	A	B	B	B
Approach Vol, veh/h		138			718			1150			829	
Approach Delay, s/veh		37.8			45.3			1.8			12.4	
Approach LOS		D			D			A			B	

Timer	1	2	3	4	5	6	7	8
Assigned Phs		2		4	5	6		8
Phs Duration (G+Y+Rc), s		82.8		47.2	15.0	67.8		47.2
Change Period (Y+Rc), s		6.0		6.0	6.0	6.0		6.0
Max Green Setting (Gmax), s		70.0		48.0	13.0	51.0		48.0
Max Q Clear Time (g_c+I1), s		13.1		33.3	7.6	3.7		38.0
Green Ext Time (p_c), s		18.6		3.8	0.2	17.7		3.2

Intersection Summary	
HCM 2010 Ctrl Delay	17.7
HCM 2010 LOS	B

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Volume (veh/h)	202	164	143	633	846	116
Number	3	18	1	6	2	12
Initial Q (Qb), veh	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00	1.00	1.00			1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1810	1810	1792	1792	1810	1810
Adj Flow Rate, veh/h	224	182	159	703	940	129
Adj No. of Lanes	1	1	1	2	2	1
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90
Percent Heavy Veh, %	5	5	6	6	5	5
Cap, veh/h	281	251	428	2279	2301	1029
Arrive On Green	0.16	0.16	0.89	0.89	0.89	0.89
Sat Flow, veh/h	1723	1538	506	3495	3529	1538
Grp Volume(v), veh/h	224	182	159	703	940	129
Grp Sat Flow(s),veh/h/ln	1723	1538	506	1703	1719	1538
Q Serve(g_s), s	8.0	7.2	5.9	2.0	3.0	0.7
Cycle Q Clear(g_c), s	8.0	7.2	9.0	2.0	3.0	0.7
Prop In Lane	1.00	1.00	1.00			1.00
Lane Grp Cap(c), veh/h	281	251	428	2279	2301	1029
V/C Ratio(X)	0.80	0.73	0.37	0.31	0.41	0.13
Avail Cap(c_a), veh/h	352	314	428	2279	2301	1029
HCM Platoon Ratio	1.00	1.00	1.33	1.33	1.33	1.33
Upstream Filter(I)	0.88	0.88	0.77	0.77	0.91	0.91
Uniform Delay (d), s/veh	25.6	25.3	2.1	1.3	1.3	1.2
Incr Delay (d2), s/veh	8.7	5.5	1.9	0.3	0.5	0.2
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	4.5	3.4	1.0	0.9	1.4	0.3
LnGrp Delay(d),s/veh	34.4	30.8	4.0	1.5	1.8	1.4
LnGrp LOS	C	C	A	A	A	A
Approach Vol, veh/h	406			862	1069	
Approach Delay, s/veh	32.8			2.0	1.8	
Approach LOS	C			A	A	

Timer	1	2	3	4	5	6	7	8
Assigned Phs		2				6		8
Phs Duration (G+Y+Rc), s		48.6				48.6		16.4
Change Period (Y+Rc), s		6.0				6.0		6.0
Max Green Setting (Gmax), s		40.0				40.0		13.0
Max Q Clear Time (g_c+I1), s		5.0				11.0		10.0
Green Ext Time (p_c), s		19.2				17.2		0.4

Intersection Summary	
HCM 2010 Ctrl Delay	7.2
HCM 2010 LOS	A

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Volume (veh/h)	187	115	210	926	620	156
Number	3	18	1	6	2	12
Initial Q (Qb), veh	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00	1.00	1.00			1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1827	1827	1810	1810	1810	1810
Adj Flow Rate, veh/h	208	128	233	1029	689	173
Adj No. of Lanes	1	1	1	2	2	1
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90
Percent Heavy Veh, %	4	4	5	5	5	5
Cap, veh/h	267	239	543	2372	2372	1061
Arrive On Green	0.15	0.15	0.92	0.92	1.00	1.00
Sat Flow, veh/h	1740	1553	621	3529	3529	1538
Grp Volume(v), veh/h	208	128	233	1029	689	173
Grp Sat Flow(s),veh/h/ln	1740	1553	621	1719	1719	1538
Q Serve(g_s), s	7.2	4.8	3.9	2.6	0.0	0.0
Cycle Q Clear(g_c), s	7.2	4.8	3.9	2.6	0.0	0.0
Prop In Lane	1.00	1.00	1.00			1.00
Lane Grp Cap(c), veh/h	267	239	543	2372	2372	1061
V/C Ratio(X)	0.78	0.54	0.43	0.43	0.29	0.16
Avail Cap(c_a), veh/h	388	346	543	2372	2372	1061
HCM Platoon Ratio	1.00	1.00	1.33	1.33	2.00	2.00
Upstream Filter(I)	0.96	0.96	0.58	0.58	0.97	0.97
Uniform Delay (d), s/veh	25.6	24.5	1.0	0.9	0.0	0.0
Incr Delay (d2), s/veh	5.8	1.8	1.4	0.3	0.3	0.3
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	3.9	2.1	0.8	1.1	0.1	0.1
LnGrp Delay(d),s/veh	31.4	26.3	2.4	1.2	0.3	0.3
LnGrp LOS	C	C	A	A	A	A
Approach Vol, veh/h	336			1262	862	
Approach Delay, s/veh	29.4			1.5	0.3	
Approach LOS	C			A	A	

Timer	1	2	3	4	5	6	7	8
Assigned Phs		2				6		8
Phs Duration (G+Y+Rc), s		49.3				49.3		15.7
Change Period (Y+Rc), s		6.0				6.0		6.0
Max Green Setting (Gmax), s		39.0				39.0		14.0
Max Q Clear Time (g_c+I1), s		2.0				5.9		9.2
Green Ext Time (p_c), s		21.6				20.2		0.5

Intersection Summary	
HCM 2010 Ctrl Delay	4.9
HCM 2010 LOS	A

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	390	768	327	41	386	41	121	396	21	83	633	303
Number	3	8	18	7	4	14	1	6	16	5	2	12
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1810	1810	1900	1810	1810	1900	1759	1759	1900	1792	1792	1792
Adj Flow Rate, veh/h	433	853	363	46	429	46	134	440	23	92	703	337
Adj No. of Lanes	1	2	0	1	2	0	1	2	0	1	2	1
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Percent Heavy Veh, %	5	5	5	5	5	5	8	8	8	6	6	6
Cap, veh/h	497	1110	470	132	673	72	296	1496	78	364	1174	844
Arrive On Green	0.21	0.47	0.47	0.21	0.21	0.21	0.14	0.93	0.93	0.69	0.69	0.69
Sat Flow, veh/h	1723	2355	998	444	3135	335	1675	3232	169	891	3406	1524
Grp Volume(v), veh/h	433	622	594	46	234	241	134	227	236	92	703	337
Grp Sat Flow(s),veh/h/ln	1723	1719	1633	444	1719	1750	1675	1671	1730	891	1703	1524
Q Serve(g_s), s	23.7	37.8	38.2	12.1	15.7	15.8	6.3	1.7	1.8	5.1	13.8	10.6
Cycle Q Clear(g_c), s	23.7	37.8	38.2	17.8	15.7	15.8	6.3	1.7	1.8	5.1	13.8	10.6
Prop In Lane	1.00		0.61	1.00		0.19	1.00		0.10	1.00		1.00
Lane Grp Cap(c), veh/h	497	811	770	132	369	376	296	774	801	364	1174	844
V/C Ratio(X)	0.87	0.77	0.77	0.35	0.64	0.64	0.45	0.29	0.29	0.25	0.60	0.40
Avail Cap(c_a), veh/h	560	912	867	142	408	416	297	774	801	364	1174	844
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	2.00	2.00	2.00	2.00	2.00	2.00
Upstream Filter(I)	0.58	0.58	0.58	0.90	0.90	0.90	0.98	0.98	0.98	0.90	0.90	0.90
Uniform Delay (d), s/veh	28.8	27.6	27.7	48.6	45.1	45.1	21.7	2.6	2.6	13.6	15.0	7.1
Incr Delay (d2), s/veh	8.1	2.1	2.3	1.4	2.5	2.6	1.1	0.9	0.9	1.5	2.0	1.3
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	12.3	18.4	17.7	1.5	7.7	7.9	3.0	0.9	1.0	1.4	6.5	4.5
LnGrp Delay(d),s/veh	36.8	29.7	30.0	50.0	47.6	47.7	22.8	3.5	3.5	15.1	17.0	8.3
LnGrp LOS	D	C	C	D	D	D	C	A	A	B	B	A
Approach Vol, veh/h		1649			521			597			1132	
Approach Delay, s/veh		31.7			47.9			7.8			14.3	
Approach LOS		C			D			A			B	

Timer	1	2	3	4	5	6	7	8
Assigned Phs	1	2	3	4		6		8
Phs Duration (G+Y+Rc), s	14.9	49.5	32.4	33.1		64.5		65.5
Change Period (Y+Rc), s	6.0	6.0	6.0	6.0		6.0		6.0
Max Green Setting (Gmax), s	9.0	36.0	31.0	30.0		51.0		67.0
Max Q Clear Time (g_c+I1), s	8.3	15.8	25.7	19.8		3.8		40.2
Green Ext Time (p_c), s	0.0	9.6	0.7	7.3		12.8		14.1

Intersection Summary	
HCM 2010 Ctrl Delay	25.1
HCM 2010 LOS	C

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	407	426	160	34	742	87	320	618	54	57	421	320
Number	3	8	18	7	4	14	1	6	16	5	2	12
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1827	1827	1900	1827	1827	1900	1776	1776	1900	1810	1810	1810
Adj Flow Rate, veh/h	452	473	178	38	824	97	356	687	60	63	468	356
Adj No. of Lanes	1	2	0	1	2	0	1	2	0	1	2	1
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Percent Heavy Veh, %	4	4	4	4	4	4	7	7	7	5	5	5
Cap, veh/h	457	1332	498	255	818	96	344	1159	101	167	582	615
Arrive On Green	0.23	0.54	0.54	0.26	0.26	0.26	0.05	0.12	0.12	0.34	0.34	0.34
Sat Flow, veh/h	1740	2474	925	763	3129	368	1691	3140	274	691	3438	1538
Grp Volume(v), veh/h	452	331	320	38	457	464	356	369	378	63	468	356
Grp Sat Flow(s),veh/h/ln	1740	1736	1664	763	1736	1762	1691	1687	1727	691	1719	1538
Q Serve(g_s), s	29.5	14.1	14.3	5.0	34.0	34.0	20.0	26.9	26.9	9.8	16.1	22.0
Cycle Q Clear(g_c), s	29.5	14.1	14.3	5.0	34.0	34.0	20.0	26.9	26.9	10.7	16.1	22.0
Prop In Lane	1.00		0.56	1.00		0.21	1.00		0.16	1.00		1.00
Lane Grp Cap(c), veh/h	457	935	896	255	454	461	344	623	638	167	582	615
V/C Ratio(X)	0.99	0.35	0.36	0.15	1.01	1.01	1.03	0.59	0.59	0.38	0.80	0.58
Avail Cap(c_a), veh/h	457	935	896	255	454	461	344	623	638	167	582	615
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	0.33	0.33	0.33	2.00	2.00	2.00
Upstream Filter(I)	0.88	0.88	0.88	0.84	0.84	0.84	0.91	0.91	0.91	0.96	0.96	0.96
Uniform Delay (d), s/veh	40.2	17.1	17.1	37.3	48.0	48.0	42.8	47.8	47.8	39.7	41.0	25.0
Incr Delay (d2), s/veh	36.6	0.2	0.2	0.2	40.4	40.1	55.3	3.7	3.7	6.1	10.8	3.8
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	20.8	6.9	6.6	1.1	21.4	21.7	8.3	13.2	13.5	2.1	8.4	11.3
LnGrp Delay(d),s/veh	76.8	17.3	17.4	37.5	88.4	88.2	98.2	51.6	51.5	45.8	51.9	28.7
LnGrp LOS	E	B	B	D	F	F	F	D	D	D	D	C
Approach Vol, veh/h		1103			959			1103			887	
Approach Delay, s/veh		41.7			86.3			66.6			42.2	
Approach LOS		D			F			E			D	

Timer	1	2	3	4	5	6	7	8
Assigned Phs	1	2	3	4		6		8
Phs Duration (G+Y+Rc), s	26.0	28.0	36.0	40.0		54.0		76.0
Change Period (Y+Rc), s	6.0	6.0	6.0	6.0		6.0		6.0
Max Green Setting (Gmax), s	20.0	22.0	30.0	34.0		48.0		70.0
Max Q Clear Time (g_c+I1), s	22.0	24.0	31.5	36.0		28.9		16.3
Green Ext Time (p_c), s	0.0	0.0	0.0	0.0		9.5		15.0

Intersection Summary	
HCM 2010 Ctrl Delay	59.1
HCM 2010 LOS	E

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	21	54	123	24	51	128	28	399	20	98	764	39
Number	3	8	18	7	4	14	1	6	16	5	2	12
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1900	1863	1900	1900	1792	1900	1759	1759	1900	1759	1759	1759
Adj Flow Rate, veh/h	23	60	137	27	57	142	31	443	22	109	849	43
Adj No. of Lanes	0	1	0	0	1	0	1	2	0	1	2	1
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Percent Heavy Veh, %	2	2	2	6	6	6	8	8	8	8	8	8
Cap, veh/h	52	93	185	56	84	178	470	2258	112	751	2746	1228
Arrive On Green	0.18	0.18	0.18	0.18	0.18	0.18	0.70	0.70	0.70	0.15	1.00	1.00
Sat Flow, veh/h	105	522	1035	121	469	998	587	3242	161	1675	3343	1495
Grp Volume(v), veh/h	220	0	0	226	0	0	31	228	237	109	849	43
Grp Sat Flow(s),veh/h/ln	1662	0	0	1588	0	0	587	1671	1731	1675	1671	1495
Q Serve(g_s), s	0.0	0.0	0.0	1.3	0.0	0.0	2.0	5.7	5.7	1.7	0.0	0.0
Cycle Q Clear(g_c), s	14.6	0.0	0.0	15.8	0.0	0.0	2.0	5.7	5.7	1.7	0.0	0.0
Prop In Lane	0.10		0.62	0.12		0.63	1.00		0.09	1.00		1.00
Lane Grp Cap(c), veh/h	330	0	0	317	0	0	470	1164	1206	751	2746	1228
V/C Ratio(X)	0.67	0.00	0.00	0.71	0.00	0.00	0.07	0.20	0.20	0.15	0.31	0.04
Avail Cap(c_a), veh/h	653	0	0	626	0	0	470	1164	1206	854	2746	1228
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	2.00	2.00	2.00
Upstream Filter(I)	1.00	0.00	0.00	0.90	0.00	0.00	1.00	1.00	1.00	0.74	0.74	0.74
Uniform Delay (d), s/veh	45.8	0.0	0.0	46.3	0.0	0.0	5.7	6.3	6.3	2.9	0.0	0.0
Incr Delay (d2), s/veh	2.3	0.0	0.0	2.7	0.0	0.0	0.3	0.4	0.4	0.1	0.2	0.0
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	7.0	0.0	0.0	7.3	0.0	0.0	0.4	2.7	2.8	0.7	0.1	0.0
LnGrp Delay(d),s/veh	48.2	0.0	0.0	49.0	0.0	0.0	6.0	6.7	6.7	2.9	0.2	0.0
LnGrp LOS	D			D			A	A	A	A	A	A
Approach Vol, veh/h		220			226			496			1001	
Approach Delay, s/veh		48.2			49.0			6.6			0.5	
Approach LOS		D			D			A			A	

Timer	1	2	3	4	5	6	7	8
Assigned Phs		2		4	5	6		8
Phs Duration (G+Y+Rc), s		103.0		27.0	14.7	88.2		27.0
Change Period (Y+Rc), s		6.0		6.0	6.0	6.0		6.0
Max Green Setting (Gmax), s		73.0		45.0	16.0	51.0		45.0
Max Q Clear Time (g_c+I1), s		2.0		17.8	3.7	7.7		16.6
Green Ext Time (p_c), s		13.0		3.2	0.2	12.2		3.3

Intersection Summary	
HCM 2010 Ctrl Delay	13.1
HCM 2010 LOS	B

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	68	56	55	17	65	160	74	736	31	94	482	60
Number	3	8	18	7	4	14	1	6	16	5	2	12
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1900	1863	1900	1900	1810	1900	1792	1792	1900	1776	1776	1776
Adj Flow Rate, veh/h	76	62	61	19	72	178	82	818	34	104	536	67
Adj No. of Lanes	0	1	0	0	1	0	1	2	0	1	2	1
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Percent Heavy Veh, %	2	2	2	5	5	5	6	6	6	7	7	7
Cap, veh/h	118	96	77	46	106	234	552	2098	87	493	2531	1132
Arrive On Green	0.22	0.22	0.22	0.22	0.22	0.22	0.63	0.63	0.63	0.07	0.75	0.75
Sat Flow, veh/h	360	444	355	65	490	1086	782	3332	138	1691	3374	1509
Grp Volume(v), veh/h	199	0	0	269	0	0	82	418	434	104	536	67
Grp Sat Flow(s),veh/h/ln	1159	0	0	1641	0	0	782	1703	1768	1691	1687	1509
Q Serve(g_s), s	2.6	0.0	0.0	0.0	0.0	0.0	5.3	14.7	14.7	2.3	5.8	1.4
Cycle Q Clear(g_c), s	21.3	0.0	0.0	18.7	0.0	0.0	5.3	14.7	14.7	2.3	5.8	1.4
Prop In Lane	0.38		0.31	0.07		0.66	1.00		0.08	1.00		1.00
Lane Grp Cap(c), veh/h	291	0	0	385	0	0	552	1072	1113	493	2531	1132
V/C Ratio(X)	0.68	0.00	0.00	0.70	0.00	0.00	0.15	0.39	0.39	0.21	0.21	0.06
Avail Cap(c_a), veh/h	474	0	0	587	0	0	552	1072	1113	566	2531	1132
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	0.00	0.00	0.97	0.00	0.00	1.00	1.00	1.00	0.56	0.56	0.56
Uniform Delay (d), s/veh	45.4	0.0	0.0	45.0	0.0	0.0	9.4	11.1	11.1	6.6	4.5	4.0
Incr Delay (d2), s/veh	2.8	0.0	0.0	2.2	0.0	0.0	0.6	1.1	1.0	0.1	0.1	0.1
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	6.7	0.0	0.0	8.8	0.0	0.0	1.2	7.2	7.4	1.0	2.7	0.6
LnGrp Delay(d),s/veh	48.3	0.0	0.0	47.2	0.0	0.0	9.9	12.2	12.1	6.7	4.6	4.0
LnGrp LOS	D			D			A	B	B	A	A	A
Approach Vol, veh/h		199			269			934			707	
Approach Delay, s/veh		48.3			47.2			12.0			4.9	
Approach LOS		D			D			B			A	

Timer	1	2	3	4	5	6	7	8
Assigned Phs		2		4	5	6		8
Phs Duration (G+Y+Rc), s		97.7		32.3	14.7	82.9		32.3
Change Period (Y+Rc), s		6.0		6.0	6.0	6.0		6.0
Max Green Setting (Gmax), s		76.0		42.0	14.0	56.0		42.0
Max Q Clear Time (g_c+I1), s		7.8		20.7	4.3	16.7		23.3
Green Ext Time (p_c), s		14.3		3.2	0.1	13.0		3.1

Intersection Summary	
HCM 2010 Ctrl Delay	17.5
HCM 2010 LOS	B

Intersection	
Int Delay, s/veh	2.5

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Vol, veh/h	0	307	178	20	507	428
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	-	0	-	-	250	-
Veh in Median Storage, #	0	-	0	-	-	0
Grade, %	0	-	0	-	-	0
Peak Hour Factor	90	90	90	90	90	90
Heavy Vehicles, %	11	11	2	2	8	8
Mvmt Flow	0	341	198	22	563	476

Major/Minor	Minor1		Major1		Major2	
Conflicting Flow All	1573	110	0	0	220	0
Stage 1	209	-	-	-	-	-
Stage 2	1364	-	-	-	-	-
Critical Hdwy	7.02	7.12	-	-	4.26	-
Critical Hdwy Stg 1	6.02	-	-	-	-	-
Critical Hdwy Stg 2	6.02	-	-	-	-	-
Follow-up Hdwy	3.61	3.41	-	-	2.28	-
Pot Cap-1 Maneuver	92	894	-	-	1304	-
Stage 1	779	-	-	-	-	-
Stage 2	187	-	-	-	-	-
Platoon blocked, %			-	-		-
Mov Cap-1 Maneuver	52	894	-	-	1304	-
Mov Cap-2 Maneuver	93	-	-	-	-	-
Stage 1	779	-	-	-	-	-
Stage 2	106	-	-	-	-	-

Approach	WB	NB	SB
HCM Control Delay, s	11.5		
HCM LOS	B		

Minor Lane/Major Mvmt	NBT	NBR	WBLn1	SBL	SBT
Capacity (veh/h)	-	-	894	1304	-
HCM Lane V/C Ratio	-	-	0.382	0.432	-
HCM Control Delay (s)	-	-	11.5	9.8	-
HCM Lane LOS	-	-	B	A	-
HCM 95th %tile Q(veh)	-	-	2	2	-

Intersection	
Int Delay, s/veh	6.4

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Vol, veh/h	0	452	380	37	307	184
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	-	0	-	-	250	-
Veh in Median Storage, #	0	-	0	-	-	0
Grade, %	0	-	0	-	-	0
Peak Hour Factor	90	90	90	90	90	90
Heavy Vehicles, %	11	11	2	2	6	6
Mvmt Flow	0	502	422	41	341	204

Major/Minor	Minor1		Major1		Major2	
Conflicting Flow All	1227	232	0	0	463	0
Stage 1	443	-	-	-	-	-
Stage 2	784	-	-	-	-	-
Critical Hdwy	7.02	7.12	-	-	4.22	-
Critical Hdwy Stg 1	6.02	-	-	-	-	-
Critical Hdwy Stg 2	6.02	-	-	-	-	-
Follow-up Hdwy	3.61	3.41	-	-	2.26	-
Pot Cap-1 Maneuver	158	743	-	-	1067	-
Stage 1	589	-	-	-	-	-
Stage 2	388	-	-	-	-	-
Platoon blocked, %			-	-		-
Mov Cap-1 Maneuver	108	743	-	-	1067	-
Mov Cap-2 Maneuver	206	-	-	-	-	-
Stage 1	589	-	-	-	-	-
Stage 2	264	-	-	-	-	-

Approach	WB	NB	SB
HCM Control Delay, s	19.3		
HCM LOS	C		

Minor Lane/Major Mvmt	NBT	NBR	WBLn1	SBL	SBT
Capacity (veh/h)	-	-	743	1067	-
HCM Lane V/C Ratio	-	-	0.676	0.32	-
HCM Control Delay (s)	-	-	19.3	10	-
HCM Lane LOS	-	-	C	A	-
HCM 95th %tile Q(veh)	-	-	5	1	-

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	4	152	11	50	33	41	15	239	16	154	419	14
Number	3	8	18	7	4	14	1	6	16	5	2	12
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1900	1863	1900	1900	1743	1743	1759	1759	1759	1712	1712	1900
Adj Flow Rate, veh/h	4	169	12	56	37	46	17	266	18	171	466	16
Adj No. of Lanes	0	1	0	0	1	1	1	1	1	1	1	0
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Percent Heavy Veh, %	2	2	2	9	9	9	8	8	8	11	11	11
Cap, veh/h	81	567	40	371	214	492	310	731	622	464	684	23
Arrive On Green	0.33	0.33	0.33	0.33	0.33	0.33	0.42	0.42	0.42	0.42	0.42	0.42
Sat Flow, veh/h	10	1708	119	754	644	1482	859	1759	1495	1002	1645	56
Grp Volume(v), veh/h	185	0	0	93	0	46	17	266	18	171	0	482
Grp Sat Flow(s),veh/h/ln	1837	0	0	1398	0	1482	859	1759	1495	1002	0	1702
Q Serve(g_s), s	0.0	0.0	0.0	0.0	0.0	1.0	0.8	4.9	0.3	6.7	0.0	11.0
Cycle Q Clear(g_c), s	3.5	0.0	0.0	1.8	0.0	1.0	11.8	4.9	0.3	11.7	0.0	11.0
Prop In Lane	0.02		0.06	0.60		1.00	1.00		1.00	1.00		0.03
Lane Grp Cap(c), veh/h	687	0	0	585	0	492	310	731	622	464	0	707
V/C Ratio(X)	0.27	0.00	0.00	0.16	0.00	0.09	0.05	0.36	0.03	0.37	0.00	0.68
Avail Cap(c_a), veh/h	849	0	0	701	0	623	640	1406	1195	848	0	1360
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	0.00	0.00	1.00	0.00	1.00	1.00	1.00	1.00	1.00	0.00	1.00
Uniform Delay (d), s/veh	11.8	0.0	0.0	11.2	0.0	11.0	16.1	9.6	8.2	13.6	0.0	11.3
Incr Delay (d2), s/veh	0.2	0.0	0.0	0.1	0.0	0.1	0.1	0.3	0.0	0.5	0.0	1.2
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	1.8	0.0	0.0	0.9	0.0	0.4	0.2	2.4	0.1	1.9	0.0	5.3
LnGrp Delay(d),s/veh	12.0	0.0	0.0	11.3	0.0	11.0	16.2	9.9	8.2	14.1	0.0	12.5
LnGrp LOS	B			B		B	B	A	A	B		B
Approach Vol, veh/h		185			139			301			653	
Approach Delay, s/veh		12.0			11.2			10.1			12.9	
Approach LOS		B			B			B			B	

Timer	1	2	3	4	5	6	7	8
Assigned Phs		2		4		6		8
Phs Duration (G+Y+Rc), s		25.8		21.8		25.8		21.8
Change Period (Y+Rc), s		6.0		6.0		6.0		6.0
Max Green Setting (Gmax), s		38.0		20.0		38.0		20.0
Max Q Clear Time (g_c+I1), s		13.7		3.8		13.8		5.5
Green Ext Time (p_c), s		6.0		1.6		6.0		1.6

Intersection Summary	
HCM 2010 Ctrl Delay	11.9
HCM 2010 LOS	B

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	7	37	14	27	108	112	7	377	32	48	254	5
Number	3	8	18	7	4	14	1	6	16	5	2	12
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1900	1863	1900	1900	1743	1743	1776	1776	1776	1712	1712	1900
Adj Flow Rate, veh/h	8	41	16	30	120	124	8	419	36	53	282	6
Adj No. of Lanes	0	1	0	0	1	1	1	1	1	1	1	0
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Percent Heavy Veh, %	2	2	2	9	9	9	7	7	7	11	11	11
Cap, veh/h	118	421	147	159	512	511	436	697	592	333	655	14
Arrive On Green	0.35	0.35	0.35	0.35	0.35	0.35	0.39	0.39	0.39	0.39	0.39	0.39
Sat Flow, veh/h	85	1221	426	188	1482	1482	1036	1776	1509	857	1670	36
Grp Volume(v), veh/h	65	0	0	150	0	124	8	419	36	53	0	288
Grp Sat Flow(s),veh/h/ln	1732	0	0	1670	0	1482	1036	1776	1509	857	0	1705
Q Serve(g_s), s	0.0	0.0	0.0	0.0	0.0	2.7	0.3	8.6	0.7	2.4	0.0	5.6
Cycle Q Clear(g_c), s	1.1	0.0	0.0	2.8	0.0	2.7	5.9	8.6	0.7	11.0	0.0	5.6
Prop In Lane	0.12		0.25	0.20		1.00	1.00		1.00	1.00		0.02
Lane Grp Cap(c), veh/h	686	0	0	671	0	511	436	697	592	333	0	669
V/C Ratio(X)	0.09	0.00	0.00	0.22	0.00	0.24	0.02	0.60	0.06	0.16	0.00	0.43
Avail Cap(c_a), veh/h	875	0	0	855	0	680	868	1436	1221	690	0	1380
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	0.00	0.00	1.00	0.00	1.00	1.00	1.00	1.00	1.00	0.00	1.00
Uniform Delay (d), s/veh	10.2	0.0	0.0	10.7	0.0	10.7	12.3	11.0	8.6	15.4	0.0	10.2
Incr Delay (d2), s/veh	0.1	0.0	0.0	0.2	0.0	0.2	0.0	0.8	0.0	0.2	0.0	0.4
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	0.6	0.0	0.0	1.4	0.0	1.1	0.1	4.4	0.3	0.6	0.0	2.7
LnGrp Delay(d),s/veh	10.2	0.0	0.0	10.9	0.0	10.9	12.3	11.9	8.7	15.6	0.0	10.6
LnGrp LOS	B			B		B	B	B	A	B		B
Approach Vol, veh/h		65			274			463			341	
Approach Delay, s/veh		10.2			10.9			11.6			11.4	
Approach LOS		B			B			B			B	

Timer	1	2	3	4	5	6	7	8
Assigned Phs		2		4		6		8
Phs Duration (G+Y+Rc), s		24.0		21.8		24.0		21.8
Change Period (Y+Rc), s		6.0		6.0		6.0		6.0
Max Green Setting (Gmax), s		37.0		21.0		37.0		21.0
Max Q Clear Time (g_c+I1), s		13.0		4.8		10.6		3.1
Green Ext Time (p_c), s		5.0		1.5		5.1		1.6

Intersection Summary	
HCM 2010 Ctrl Delay	11.3
HCM 2010 LOS	B

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Volume (veh/h)	9	9	249	6	12	459
Number	3	18	2	12	1	6
Initial Q (Qb), veh	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00	1.00		1.00	1.00	
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1667	1667	1776	1900	1759	1759
Adj Flow Rate, veh/h	10	10	277	7	13	510
Adj No. of Lanes	2	1	2	0	1	2
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90
Percent Heavy Veh, %	14	14	7	7	8	8
Cap, veh/h	142	65	1833	46	765	1822
Arrive On Green	0.05	0.05	0.55	0.55	0.55	0.55
Sat Flow, veh/h	3079	1417	3452	85	1030	3431
Grp Volume(v), veh/h	10	10	139	145	13	510
Grp Sat Flow(s),veh/h/ln	1540	1417	1687	1761	1030	1671
Q Serve(g_s), s	0.1	0.2	1.2	1.2	0.2	2.4
Cycle Q Clear(g_c), s	0.1	0.2	1.2	1.2	1.4	2.4
Prop In Lane	1.00	1.00		0.05	1.00	
Lane Grp Cap(c), veh/h	142	65	919	960	765	1822
V/C Ratio(X)	0.07	0.15	0.15	0.15	0.02	0.28
Avail Cap(c_a), veh/h	1469	676	1954	2039	1396	3872
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	13.4	13.4	3.3	3.3	3.7	3.6
Incr Delay (d2), s/veh	0.2	1.1	0.1	0.1	0.0	0.1
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	0.0	0.1	0.6	0.6	0.1	1.1
LnGrp Delay(d),s/veh	13.6	14.5	3.4	3.4	3.7	3.7
LnGrp LOS	B	B	A	A	A	A
Approach Vol, veh/h	20		284			523
Approach Delay, s/veh	14.1		3.4			3.7
Approach LOS	B		A			A

Timer	1	2	3	4	5	6	7	8
Assigned Phs		2				6		8
Phs Duration (G+Y+Rc), s		22.0				22.0		7.4
Change Period (Y+Rc), s		6.0				6.0		6.0
Max Green Setting (Gmax), s		34.0				34.0		14.0
Max Q Clear Time (g_c+I1), s		3.2				4.4		2.2
Green Ext Time (p_c), s		5.6				5.5		0.0

Intersection Summary	
HCM 2010 Ctrl Delay	3.8
HCM 2010 LOS	A

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Volume (veh/h)	6	7	436	13	10	282
Number	3	18	2	12	1	6
Initial Q (Qb), veh	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00	1.00		1.00	1.00	
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1712	1712	1810	1900	1776	1776
Adj Flow Rate, veh/h	7	8	484	14	11	313
Adj No. of Lanes	2	1	2	0	1	2
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90
Percent Heavy Veh, %	11	11	5	5	7	7
Cap, veh/h	112	51	1881	54	656	1860
Arrive On Green	0.04	0.04	0.55	0.55	0.55	0.55
Sat Flow, veh/h	3163	1455	3503	99	854	3463
Grp Volume(v), veh/h	7	8	244	254	11	313
Grp Sat Flow(s),veh/h/ln	1581	1455	1719	1792	854	1687
Q Serve(g_s), s	0.1	0.2	2.1	2.2	0.2	1.3
Cycle Q Clear(g_c), s	0.1	0.2	2.1	2.2	2.4	1.3
Prop In Lane	1.00	1.00		0.06	1.00	
Lane Grp Cap(c), veh/h	112	51	948	988	656	1860
V/C Ratio(X)	0.06	0.16	0.26	0.26	0.02	0.17
Avail Cap(c_a), veh/h	1634	752	1954	2038	1156	3836
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	13.5	13.6	3.4	3.4	4.0	3.2
Incr Delay (d2), s/veh	0.2	1.4	0.1	0.1	0.0	0.0
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	0.0	0.1	1.1	1.1	0.0	0.6
LnGrp Delay(d),s/veh	13.8	15.0	3.5	3.5	4.0	3.3
LnGrp LOS	B	B	A	A	A	A
Approach Vol, veh/h	15		498			324
Approach Delay, s/veh	14.4		3.5			3.3
Approach LOS	B		A			A

Timer	1	2	3	4	5	6	7	8
Assigned Phs		2				6		8
Phs Duration (G+Y+Rc), s		22.0				22.0		7.0
Change Period (Y+Rc), s		6.0				6.0		6.0
Max Green Setting (Gmax), s		33.0				33.0		15.0
Max Q Clear Time (g_c+I1), s		4.2				4.4		2.2
Green Ext Time (p_c), s		5.5				5.4		0.0

Intersection Summary	
HCM 2010 Ctrl Delay	3.6
HCM 2010 LOS	A

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	4	176	255	92	106	14	103	61	177	14	129	14
Number	5	2	12	1	6	16	3	8	18	7	4	14
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1845	1845	1900	1827	1827	1900	1776	1776	1900	1863	1863	1900
Adj Flow Rate, veh/h	4	196	283	102	118	16	114	68	197	16	143	16
Adj No. of Lanes	1	1	0	1	1	0	1	1	0	1	1	0
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Percent Heavy Veh, %	3	3	3	4	4	4	7	7	7	2	2	2
Cap, veh/h	552	243	351	402	891	121	317	100	290	218	408	46
Arrive On Green	0.36	0.36	0.36	0.12	0.57	0.57	0.25	0.25	0.25	0.25	0.25	0.25
Sat Flow, veh/h	1238	684	987	1740	1576	214	1165	403	1167	1110	1646	184
Grp Volume(v), veh/h	4	0	479	102	0	134	114	0	265	16	0	159
Grp Sat Flow(s),veh/h/ln	1238	0	1670	1740	0	1789	1165	0	1570	1110	0	1830
Q Serve(g_s), s	0.1	0.0	16.7	2.0	0.0	2.3	5.8	0.0	9.8	0.9	0.0	4.6
Cycle Q Clear(g_c), s	0.1	0.0	16.7	2.0	0.0	2.3	10.4	0.0	9.8	10.7	0.0	4.6
Prop In Lane	1.00		0.59	1.00		0.12	1.00		0.74	1.00		0.10
Lane Grp Cap(c), veh/h	552	0	594	402	0	1012	317	0	390	218	0	454
V/C Ratio(X)	0.01	0.00	0.81	0.25	0.00	0.13	0.36	0.00	0.68	0.07	0.00	0.35
Avail Cap(c_a), veh/h	899	0	1062	441	0	1554	426	0	536	321	0	625
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00	1.00
Uniform Delay (d), s/veh	13.4	0.0	18.8	11.5	0.0	6.6	24.2	0.0	21.9	26.8	0.0	20.0
Incr Delay (d2), s/veh	0.0	0.0	2.6	0.3	0.0	0.1	0.7	0.0	2.1	0.1	0.0	0.5
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	0.0	0.0	8.0	0.9	0.0	1.1	1.9	0.0	4.5	0.3	0.0	2.4
LnGrp Delay(d),s/veh	13.4	0.0	21.4	11.8	0.0	6.6	24.9	0.0	24.0	26.9	0.0	20.4
LnGrp LOS	B		C	B		A	C		C	C		C
Approach Vol, veh/h		483			236			379			175	
Approach Delay, s/veh		21.4			8.9			24.3			21.0	
Approach LOS		C			A			C			C	

Timer	1	2	3	4	5	6	7	8
Assigned Phs	1	2		4		6		8
Phs Duration (G+Y+Rc), s	13.6	28.9		22.0		42.5		22.0
Change Period (Y+Rc), s	6.0	6.0		6.0		6.0		6.0
Max Green Setting (Gmax), s	9.0	41.0		22.0		56.0		22.0
Max Q Clear Time (g_c+I1), s	4.0	18.7		12.7		4.3		12.4
Green Ext Time (p_c), s	0.1	4.2		2.2		4.8		2.2

Intersection Summary	
HCM 2010 Ctrl Delay	19.9
HCM 2010 LOS	B

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	14	97	148	122	173	24	186	127	133	14	57	14
Number	5	2	12	1	6	16	3	8	18	7	4	14
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1845	1845	1900	1827	1827	1900	1776	1776	1900	1863	1863	1900
Adj Flow Rate, veh/h	16	108	164	136	192	27	207	141	148	16	63	16
Adj No. of Lanes	1	1	0	1	1	0	1	1	0	1	1	0
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Percent Heavy Veh, %	3	3	3	4	4	4	7	7	7	2	2	2
Cap, veh/h	440	183	277	510	811	114	428	219	230	254	396	101
Arrive On Green	0.28	0.28	0.28	0.14	0.52	0.52	0.28	0.28	0.28	0.28	0.28	0.28
Sat Flow, veh/h	1146	662	1005	1740	1568	220	1253	795	834	1086	1434	364
Grp Volume(v), veh/h	16	0	272	136	0	219	207	0	289	16	0	79
Grp Sat Flow(s),veh/h/ln	1146	0	1667	1740	0	1788	1253	0	1629	1086	0	1798
Q Serve(g_s), s	0.6	0.0	8.2	2.7	0.0	3.9	8.7	0.0	9.1	0.8	0.0	1.9
Cycle Q Clear(g_c), s	0.6	0.0	8.2	2.7	0.0	3.9	10.6	0.0	9.1	9.8	0.0	1.9
Prop In Lane	1.00		0.60	1.00		0.12	1.00		0.51	1.00		0.20
Lane Grp Cap(c), veh/h	440	0	460	510	0	925	428	0	449	254	0	496
V/C Ratio(X)	0.04	0.00	0.59	0.27	0.00	0.24	0.48	0.00	0.64	0.06	0.00	0.16
Avail Cap(c_a), veh/h	697	0	834	600	0	1418	774	0	899	554	0	992
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00	1.00
Uniform Delay (d), s/veh	15.4	0.0	18.2	10.6	0.0	7.7	19.9	0.0	18.5	22.8	0.0	15.9
Incr Delay (d2), s/veh	0.0	0.0	1.2	0.3	0.0	0.1	0.8	0.0	1.5	0.1	0.0	0.1
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	0.2	0.0	3.9	1.3	0.0	1.9	3.1	0.0	4.2	0.2	0.0	1.0
LnGrp Delay(d),s/veh	15.5	0.0	19.4	10.9	0.0	7.8	20.8	0.0	20.0	22.9	0.0	16.0
LnGrp LOS	B		B	B		A	C		C	C		B
Approach Vol, veh/h		288			355			496			95	
Approach Delay, s/veh		19.2			9.0			20.3			17.2	
Approach LOS		B			A			C			B	

Timer	1	2	3	4	5	6	7	8
Assigned Phs	1	2		4		6		8
Phs Duration (G+Y+Rc), s	14.0	22.0		22.0		36.0		22.0
Change Period (Y+Rc), s	6.0	6.0		6.0		6.0		6.0
Max Green Setting (Gmax), s	11.0	29.0		32.0		46.0		32.0
Max Q Clear Time (g_c+I1), s	4.7	10.2		11.8		5.9		12.6
Green Ext Time (p_c), s	0.2	3.0		3.0		3.5		3.0

Intersection Summary	
HCM 2010 Ctrl Delay	16.6
HCM 2010 LOS	B

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	112	460	144	255	185	24	85	461	297	56	799	95
Number	3	8	18	7	4	14	1	6	16	5	2	12
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1792	1792	1900	1827	1827	1900	1743	1743	1900	1727	1727	1727
Adj Flow Rate, veh/h	124	511	160	283	206	27	94	512	330	62	888	106
Adj No. of Lanes	1	2	0	1	2	0	1	1	0	1	1	1
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Percent Heavy Veh, %	6	6	6	4	4	4	9	9	9	10	10	10
Cap, veh/h	459	995	310	256	1202	156	80	474	305	80	825	701
Arrive On Green	0.39	0.39	0.39	0.39	0.39	0.39	0.48	0.48	0.48	0.48	0.48	0.48
Sat Flow, veh/h	1100	2558	797	749	3092	400	528	991	639	603	1727	1468
Grp Volume(v), veh/h	124	339	332	283	114	119	94	0	842	62	888	106
Grp Sat Flow(s),veh/h/ln	1100	1703	1652	749	1736	1756	528	0	1630	603	1727	1468
Q Serve(g_s), s	7.5	13.7	13.8	21.2	3.9	4.0	0.0	0.0	43.0	0.0	43.0	3.7
Cycle Q Clear(g_c), s	11.5	13.7	13.8	35.0	3.9	4.0	43.0	0.0	43.0	43.0	43.0	3.7
Prop In Lane	1.00		0.48	1.00		0.23	1.00		0.39	1.00		1.00
Lane Grp Cap(c), veh/h	459	662	642	256	675	683	80	0	779	80	825	701
V/C Ratio(X)	0.27	0.51	0.52	1.10	0.17	0.17	1.17	0.00	1.08	0.77	1.08	0.15
Avail Cap(c_a), veh/h	459	662	642	256	675	683	80	0	779	80	825	701
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.00	1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	21.8	21.0	21.0	37.7	18.0	18.0	45.0	0.0	23.5	45.0	23.5	13.2
Incr Delay (d2), s/veh	0.3	0.7	0.7	87.1	0.1	0.1	155.3	0.0	56.4	36.8	53.8	0.1
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	2.3	6.5	6.4	12.5	1.9	1.9	5.4	0.0	31.5	2.4	32.7	1.5
LnGrp Delay(d),s/veh	22.1	21.7	21.7	124.8	18.1	18.1	200.3	0.0	79.9	81.8	77.3	13.3
LnGrp LOS	C	C	C	F	B	B	F		F	F	F	B
Approach Vol, veh/h		795			516			936			1056	
Approach Delay, s/veh		21.8			76.6			92.0			71.2	
Approach LOS		C			E			F			E	

Timer	1	2	3	4	5	6	7	8
Assigned Phs		2		4		6		8
Phs Duration (G+Y+Rc), s		49.0		41.0		49.0		41.0
Change Period (Y+Rc), s		6.0		6.0		6.0		6.0
Max Green Setting (Gmax), s		43.0		35.0		43.0		35.0
Max Q Clear Time (g_c+I1), s		45.0		37.0		45.0		15.8
Green Ext Time (p_c), s		0.0		0.0		0.0		8.5

Intersection Summary	
HCM 2010 Ctrl Delay	66.0
HCM 2010 LOS	E

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	80	196	80	262	433	94	173	733	226	16	457	93
Number	3	8	18	7	4	14	1	6	16	5	2	12
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1810	1810	1900	1845	1845	1900	1759	1759	1900	1743	1743	1743
Adj Flow Rate, veh/h	89	218	89	291	481	104	192	814	251	18	508	103
Adj No. of Lanes	1	2	0	1	2	0	1	1	0	1	1	1
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Percent Heavy Veh, %	5	5	5	3	3	3	8	8	8	9	9	9
Cap, veh/h	186	669	265	295	797	171	400	760	234	80	1027	873
Arrive On Green	0.28	0.28	0.28	0.28	0.28	0.28	0.59	0.59	0.59	0.59	0.59	0.59
Sat Flow, veh/h	803	2408	953	1058	2871	617	762	1291	398	494	1743	1482
Grp Volume(v), veh/h	89	154	153	291	293	292	192	0	1065	18	508	103
Grp Sat Flow(s),veh/h/ln	803	1719	1641	1058	1752	1736	762	0	1689	494	1743	1482
Q Serve(g_s), s	9.7	6.4	6.7	18.3	13.0	13.2	17.6	0.0	53.0	0.0	15.2	2.8
Cycle Q Clear(g_c), s	22.9	6.4	6.7	25.0	13.0	13.2	32.8	0.0	53.0	53.0	15.2	2.8
Prop In Lane	1.00		0.58	1.00		0.36	1.00		0.24	1.00		1.00
Lane Grp Cap(c), veh/h	186	478	456	295	487	482	400	0	995	80	1027	873
V/C Ratio(X)	0.48	0.32	0.34	0.99	0.60	0.61	0.48	0.00	1.07	0.22	0.49	0.12
Avail Cap(c_a), veh/h	186	478	456	295	487	482	400	0	995	80	1027	873
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.00	1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	38.2	25.8	25.9	38.2	28.2	28.2	20.2	0.0	18.5	45.0	10.7	8.2
Incr Delay (d2), s/veh	1.9	0.4	0.4	48.5	2.1	2.2	0.9	0.0	49.5	1.4	0.4	0.1
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	2.2	3.1	3.1	11.2	6.5	6.5	3.8	0.0	38.0	0.5	7.3	1.1
LnGrp Delay(d),s/veh	40.1	26.2	26.3	86.7	30.2	30.4	21.1	0.0	68.0	46.4	11.1	8.2
LnGrp LOS	D	C	C	F	C	C	C		F	D	B	A
Approach Vol, veh/h		396			876			1257			629	
Approach Delay, s/veh		29.4			49.1			60.8			11.6	
Approach LOS		C			D			E			B	

Timer	1	2	3	4	5	6	7	8
Assigned Phs		2		4		6		8
Phs Duration (G+Y+Rc), s		59.0		31.0		59.0		31.0
Change Period (Y+Rc), s		6.0		6.0		6.0		6.0
Max Green Setting (Gmax), s		53.0		25.0		53.0		25.0
Max Q Clear Time (g_c+I1), s		55.0		27.0		55.0		24.9
Green Ext Time (p_c), s		0.0		0.0		0.0		0.1

Intersection Summary	
HCM 2010 Ctrl Delay	43.8
HCM 2010 LOS	D

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	492	159	130	4	59	4	56	303	4	4	655	364
Number	3	8	18	7	4	14	1	6	16	5	2	12
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1810	1810	1900	1845	1845	1900	1681	1681	1900	1743	1743	1743
Adj Flow Rate, veh/h	547	177	144	4	66	4	62	337	4	4	728	404
Adj No. of Lanes	1	2	0	1	2	0	1	1	0	1	1	1
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Percent Heavy Veh, %	5	5	5	3	3	3	13	13	13	9	9	9
Cap, veh/h	602	742	569	450	1344	81	111	711	8	377	747	635
Arrive On Green	0.40	0.40	0.40	0.40	0.40	0.40	0.43	0.43	0.43	0.43	0.43	0.43
Sat Flow, veh/h	1287	1855	1422	1044	3360	202	447	1658	20	969	1743	1482
Grp Volume(v), veh/h	547	163	158	4	34	36	62	0	341	4	728	404
Grp Sat Flow(s),veh/h/ln	1287	1719	1559	1044	1752	1809	447	0	1678	969	1743	1482
Q Serve(g_s), s	27.2	4.4	4.7	0.2	0.8	0.8	1.3	0.0	10.2	0.2	28.7	15.0
Cycle Q Clear(g_c), s	28.0	4.4	4.7	4.9	0.8	0.8	30.0	0.0	10.2	10.4	28.7	15.0
Prop In Lane	1.00		0.91	1.00		0.11	1.00		0.01	1.00		1.00
Lane Grp Cap(c), veh/h	602	688	623	450	701	724	111	0	719	377	747	635
V/C Ratio(X)	0.91	0.24	0.25	0.01	0.05	0.05	0.56	0.00	0.47	0.01	0.97	0.64
Avail Cap(c_a), veh/h	602	688	623	450	701	724	111	0	719	377	747	635
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.00	1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	22.6	13.9	14.0	15.7	12.9	12.9	34.9	0.0	14.3	18.1	19.6	15.7
Incr Delay (d2), s/veh	17.7	0.2	0.2	0.0	0.0	0.0	6.0	0.0	0.5	0.0	26.6	2.1
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	13.5	2.1	2.1	0.1	0.4	0.4	1.4	0.0	4.7	0.1	19.1	6.4
LnGrp Delay(d),s/veh	40.4	14.1	14.2	15.7	12.9	12.9	41.0	0.0	14.8	18.1	46.2	17.8
LnGrp LOS	D	B	B	B	B	B	D		B	B	D	B
Approach Vol, veh/h		868			74			403			1136	
Approach Delay, s/veh		30.7			13.0			18.9			36.0	
Approach LOS		C			B			B			D	

Timer	1	2	3	4	5	6	7	8
Assigned Phs		2		4		6		8
Phs Duration (G+Y+Rc), s		36.0		34.0		36.0		34.0
Change Period (Y+Rc), s		6.0		6.0		6.0		6.0
Max Green Setting (Gmax), s		30.0		28.0		30.0		28.0
Max Q Clear Time (g_c+I1), s		30.7		6.9		32.0		30.0
Green Ext Time (p_c), s		0.0		4.4		0.0		0.0

Intersection Summary	
HCM 2010 Ctrl Delay	30.7
HCM 2010 LOS	C

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	482	62	57	13	117	6	169	711	16	8	355	529
Number	3	8	18	7	4	14	1	6	16	5	2	12
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1827	1827	1900	1863	1863	1900	1727	1727	1900	1759	1759	1759
Adj Flow Rate, veh/h	536	69	63	14	130	7	188	790	18	9	394	588
Adj No. of Lanes	1	2	0	1	2	0	1	1	0	1	1	1
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Percent Heavy Veh, %	4	4	4	2	2	2	10	10	10	8	8	8
Cap, veh/h	563	726	595	571	1367	73	242	721	16	103	754	641
Arrive On Green	0.40	0.40	0.40	0.40	0.40	0.40	0.43	0.43	0.43	0.43	0.43	0.43
Sat Flow, veh/h	1223	1814	1486	1253	3417	183	529	1682	38	635	1759	1495
Grp Volume(v), veh/h	536	66	66	14	67	70	188	0	808	9	394	588
Grp Sat Flow(s),veh/h/ln	1223	1736	1565	1253	1770	1830	529	0	1721	635	1759	1495
Q Serve(g_s), s	26.3	1.7	1.9	0.5	1.7	1.7	18.5	0.0	30.0	0.0	11.5	25.9
Cycle Q Clear(g_c), s	28.0	1.7	1.9	2.4	1.7	1.7	30.0	0.0	30.0	30.0	11.5	25.9
Prop In Lane	1.00		0.95	1.00		0.10	1.00		0.02	1.00		1.00
Lane Grp Cap(c), veh/h	563	694	626	571	708	732	242	0	737	103	754	641
V/C Ratio(X)	0.95	0.09	0.11	0.02	0.09	0.10	0.78	0.00	1.10	0.09	0.52	0.92
Avail Cap(c_a), veh/h	563	694	626	571	708	732	242	0	737	103	754	641
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.00	1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	23.7	13.1	13.2	13.9	13.1	13.1	28.2	0.0	20.0	35.0	14.7	18.8
Incr Delay (d2), s/veh	26.5	0.1	0.1	0.0	0.1	0.1	14.5	0.0	62.4	0.4	0.7	18.2
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	14.4	0.8	0.8	0.2	0.8	0.8	4.6	0.0	26.9	0.2	5.7	13.9
LnGrp Delay(d),s/veh	50.2	13.2	13.2	13.9	13.2	13.2	42.7	0.0	82.4	35.4	15.4	37.1
LnGrp LOS	D	B	B	B	B	B	D		F	D	B	D
Approach Vol, veh/h		668			151			996			991	
Approach Delay, s/veh		42.9			13.2			74.9			28.4	
Approach LOS		D			B			E			C	

Timer	1	2	3	4	5	6	7	8
Assigned Phs		2		4		6		8
Phs Duration (G+Y+Rc), s		36.0		34.0		36.0		34.0
Change Period (Y+Rc), s		6.0		6.0		6.0		6.0
Max Green Setting (Gmax), s		30.0		28.0		30.0		28.0
Max Q Clear Time (g_c+I1), s		32.0		4.4		32.0		30.0
Green Ext Time (p_c), s		0.0		3.8		0.0		0.0

Intersection Summary	
HCM 2010 Ctrl Delay	47.5
HCM 2010 LOS	D

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	46	45	107	5	30	9	87	370	6	7	698	112
Number	3	8	18	7	4	14	1	6	16	5	2	12
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1900	1792	1900	1810	1810	1900	1696	1696	1900	1681	1681	1900
Adj Flow Rate, veh/h	51	50	119	6	33	10	97	411	7	8	776	124
Adj No. of Lanes	0	1	0	1	1	0	1	1	0	1	1	0
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Percent Heavy Veh, %	6	6	6	5	5	5	12	12	12	13	13	13
Cap, veh/h	102	84	158	249	251	76	237	1115	19	574	949	152
Arrive On Green	0.19	0.19	0.19	0.19	0.19	0.19	0.67	0.67	0.67	0.67	0.67	0.67
Sat Flow, veh/h	262	449	837	1177	1334	404	561	1663	28	871	1415	226
Grp Volume(v), veh/h	220	0	0	6	0	43	97	0	418	8	0	900
Grp Sat Flow(s),veh/h/ln	1547	0	0	1177	0	1738	561	0	1691	871	0	1642
Q Serve(g_s), s	7.2	0.0	0.0	0.0	0.0	1.7	12.9	0.0	9.2	0.3	0.0	34.0
Cycle Q Clear(g_c), s	11.3	0.0	0.0	0.6	0.0	1.7	46.9	0.0	9.2	9.5	0.0	34.0
Prop In Lane	0.23		0.54	1.00		0.23	1.00		0.02	1.00		0.14
Lane Grp Cap(c), veh/h	344	0	0	249	0	327	237	0	1134	574	0	1100
V/C Ratio(X)	0.64	0.00	0.00	0.02	0.00	0.13	0.41	0.00	0.37	0.01	0.00	0.82
Avail Cap(c_a), veh/h	344	0	0	249	0	328	270	0	1236	627	0	1199
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	0.00	0.00	1.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00	1.00
Uniform Delay (d), s/veh	32.5	0.0	0.0	28.2	0.0	28.7	27.3	0.0	6.1	8.2	0.0	10.2
Incr Delay (d2), s/veh	4.0	0.0	0.0	0.0	0.0	0.2	1.1	0.0	0.2	0.0	0.0	4.3
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	5.3	0.0	0.0	0.1	0.0	0.9	2.1	0.0	4.2	0.1	0.0	16.3
LnGrp Delay(d),s/veh	36.4	0.0	0.0	28.2	0.0	28.8	28.5	0.0	6.3	8.2	0.0	14.5
LnGrp LOS	D			C		C	C		A	A		B
Approach Vol, veh/h		220			49			515			908	
Approach Delay, s/veh		36.4			28.8			10.5			14.4	
Approach LOS		D			C			B			B	

Timer	1	2	3	4	5	6	7	8
Assigned Phs		2		4		6		8
Phs Duration (G+Y+Rc), s		62.9		22.0		62.9		22.0
Change Period (Y+Rc), s		6.0		6.0		6.0		6.0
Max Green Setting (Gmax), s		62.0		16.0		62.0		16.0
Max Q Clear Time (g_c+I1), s		36.0		3.7		48.9		13.3
Green Ext Time (p_c), s		12.1		1.2		8.0		0.4

Intersection Summary	
HCM 2010 Ctrl Delay	16.5
HCM 2010 LOS	B

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	60	33	91	5	45	15	122	715	4	20	339	80
Number	3	8	18	7	4	14	1	6	16	5	2	12
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1900	1810	1900	1827	1827	1900	1727	1727	1900	1727	1727	1900
Adj Flow Rate, veh/h	67	37	101	6	50	17	136	794	4	22	377	89
Adj No. of Lanes	0	1	0	1	1	0	1	1	0	1	1	0
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Percent Heavy Veh, %	5	5	5	4	4	4	10	10	10	10	10	10
Cap, veh/h	157	96	177	372	306	104	473	1010	5	253	795	188
Arrive On Green	0.23	0.23	0.23	0.23	0.23	0.23	0.59	0.59	0.59	0.59	0.59	0.59
Sat Flow, veh/h	367	409	753	1222	1305	444	856	1717	9	629	1352	319
Grp Volume(v), veh/h	205	0	0	6	0	67	136	0	798	22	0	466
Grp Sat Flow(s),veh/h/ln	1529	0	0	1222	0	1749	856	0	1726	629	0	1671
Q Serve(g_s), s	3.9	0.0	0.0	0.0	0.0	2.1	7.3	0.0	24.0	1.9	0.0	10.8
Cycle Q Clear(g_c), s	7.8	0.0	0.0	0.3	0.0	2.1	18.1	0.0	24.0	25.9	0.0	10.8
Prop In Lane	0.33		0.49	1.00		0.25	1.00		0.01	1.00		0.19
Lane Grp Cap(c), veh/h	429	0	0	372	0	411	473	0	1015	253	0	983
V/C Ratio(X)	0.48	0.00	0.00	0.02	0.00	0.16	0.29	0.00	0.79	0.09	0.00	0.47
Avail Cap(c_a), veh/h	519	0	0	446	0	516	702	0	1477	422	0	1430
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	0.00	0.00	1.00	0.00	1.00	1.00	0.00	1.00	1.00	0.00	1.00
Uniform Delay (d), s/veh	22.7	0.0	0.0	20.0	0.0	20.6	13.1	0.0	10.7	20.6	0.0	8.0
Incr Delay (d2), s/veh	0.8	0.0	0.0	0.0	0.0	0.2	0.3	0.0	1.8	0.1	0.0	0.4
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	3.5	0.0	0.0	0.1	0.0	1.0	1.7	0.0	11.8	0.3	0.0	5.0
LnGrp Delay(d),s/veh	23.5	0.0	0.0	20.0	0.0	20.8	13.5	0.0	12.5	20.8	0.0	8.3
LnGrp LOS	C			B		C	B		B	C		A
Approach Vol, veh/h		205			73			934			488	
Approach Delay, s/veh		23.5			20.8			12.6			8.9	
Approach LOS		C			C			B			A	

Timer	1	2	3	4	5	6	7	8
Assigned Phs		2		4		6		8
Phs Duration (G+Y+Rc), s		45.9		21.9		45.9		21.9
Change Period (Y+Rc), s		6.0		6.0		6.0		6.0
Max Green Setting (Gmax), s		58.0		20.0		58.0		20.0
Max Q Clear Time (g_c+I1), s		27.9		4.1		26.0		9.8
Green Ext Time (p_c), s		12.0		1.4		12.3		1.1

Intersection Summary	
HCM 2010 Ctrl Delay	13.2
HCM 2010 LOS	B

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Volume (veh/h)	60	0	425	92	0	771
Number	7	14	6	16	5	2
Initial Q (Qb), veh	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00	1.00		1.00	1.00	
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1743	1743	1681	1681	0	1696
Adj Flow Rate, veh/h	67	0	472	0	0	857
Adj No. of Lanes	1	1	1	1	0	1
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90
Percent Heavy Veh, %	9	9	13	13	0	12
Cap, veh/h	180	161	1100	935	0	1109
Arrive On Green	0.11	0.00	0.65	0.00	0.00	0.65
Sat Flow, veh/h	1660	1482	1681	1429	0	1696
Grp Volume(v), veh/h	67	0	472	0	0	857
Grp Sat Flow(s),veh/h/ln	1660	1482	1681	1429	0	1696
Q Serve(g_s), s	1.9	0.0	6.8	0.0	0.0	17.9
Cycle Q Clear(g_c), s	1.9	0.0	6.8	0.0	0.0	17.9
Prop In Lane	1.00	1.00		1.00	0.00	
Lane Grp Cap(c), veh/h	180	161	1100	935	0	1109
V/C Ratio(X)	0.37	0.00	0.43	0.00	0.00	0.77
Avail Cap(c_a), veh/h	296	264	2296	1952	0	2316
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	0.00	1.00	0.00	0.00	1.00
Uniform Delay (d), s/veh	20.9	0.0	4.2	0.0	0.0	6.1
Incr Delay (d2), s/veh	1.3	0.0	0.3	0.0	0.0	1.2
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	0.9	0.0	3.1	0.0	0.0	8.5
LnGrp Delay(d),s/veh	22.2	0.0	4.5	0.0	0.0	7.3
LnGrp LOS	C		A			A
Approach Vol, veh/h	67		472			857
Approach Delay, s/veh	22.2		4.5			7.3
Approach LOS	C		A			A

Timer	1	2	3	4	5	6	7	8
Assigned Phs		2		4		6		
Phs Duration (G+Y+Rc), s		39.0		11.5		39.0		
Change Period (Y+Rc), s		6.0		6.0		6.0		
Max Green Setting (Gmax), s		69.0		9.0		69.0		
Max Q Clear Time (g_c+I1), s		19.9		3.9		8.8		
Green Ext Time (p_c), s		13.2		0.0		13.6		

Intersection Summary	
HCM 2010 Ctrl Delay	7.1
HCM 2010 LOS	A

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Lane Configurations						
Volume (veh/h)	62	0	790	84	0	385
Number	7	14	6	16	5	2
Initial Q (Qb), veh	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00	1.00		1.00	1.00	
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1759	1759	1712	1712	0	1727
Adj Flow Rate, veh/h	69	0	878	0	0	428
Adj No. of Lanes	1	1	1	1	0	1
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90
Percent Heavy Veh, %	8	8	11	11	0	10
Cap, veh/h	184	164	1122	953	0	1132
Arrive On Green	0.11	0.00	0.66	0.00	0.00	0.66
Sat Flow, veh/h	1675	1495	1712	1455	0	1727
Grp Volume(v), veh/h	69	0	878	0	0	428
Grp Sat Flow(s),veh/h/ln	1675	1495	1712	1455	0	1727
Q Serve(g_s), s	2.0	0.0	18.6	0.0	0.0	5.8
Cycle Q Clear(g_c), s	2.0	0.0	18.6	0.0	0.0	5.8
Prop In Lane	1.00	1.00		1.00	0.00	
Lane Grp Cap(c), veh/h	184	164	1122	953	0	1132
V/C Ratio(X)	0.37	0.00	0.78	0.00	0.00	0.38
Avail Cap(c_a), veh/h	295	263	2310	1964	0	2331
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	0.00	1.00	0.00	0.00	1.00
Uniform Delay (d), s/veh	21.1	0.0	6.2	0.0	0.0	4.0
Incr Delay (d2), s/veh	1.3	0.0	1.2	0.0	0.0	0.2
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	1.0	0.0	8.9	0.0	0.0	2.8
LnGrp Delay(d),s/veh	22.4	0.0	7.5	0.0	0.0	4.2
LnGrp LOS	C		A			A
Approach Vol, veh/h	69		878			428
Approach Delay, s/veh	22.4		7.5			4.2
Approach LOS	C		A			A

Timer	1	2	3	4	5	6	7	8
Assigned Phs		2		4		6		
Phs Duration (G+Y+Rc), s		39.5		11.6		39.5		
Change Period (Y+Rc), s		6.0		6.0		6.0		
Max Green Setting (Gmax), s		69.0		9.0		69.0		
Max Q Clear Time (g_c+I1), s		7.8		4.0		20.6		
Green Ext Time (p_c), s		13.4		0.0		12.9		

Intersection Summary	
HCM 2010 Ctrl Delay	7.2
HCM 2010 LOS	A

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	6	293	20	64	68	111	17	331	226	227	468	22
Number	3	8	18	7	4	14	1	6	16	5	2	12
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1900	1743	1900	1638	1638	1638	1792	1792	1900	1681	1681	1900
Adj Flow Rate, veh/h	7	326	22	71	76	123	19	368	251	252	520	24
Adj No. of Lanes	0	2	0	1	1	1	1	1	0	1	1	0
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Percent Heavy Veh, %	9	9	9	16	16	16	6	6	6	13	13	13
Cap, veh/h	58	699	46	225	374	318	439	597	407	367	957	44
Arrive On Green	0.23	0.23	0.23	0.23	0.23	0.23	0.60	0.60	0.60	0.60	0.60	0.60
Sat Flow, veh/h	20	3058	203	904	1638	1392	826	994	678	723	1595	74
Grp Volume(v), veh/h	187	0	168	71	76	123	19	0	619	252	0	544
Grp Sat Flow(s),veh/h/ln	1731	0	1550	904	1638	1392	826	0	1673	723	0	1668
Q Serve(g_s), s	0.0	0.0	6.6	5.2	2.6	5.2	1.0	0.0	16.4	23.8	0.0	13.5
Cycle Q Clear(g_c), s	6.5	0.0	6.6	11.7	2.6	5.2	14.5	0.0	16.4	40.2	0.0	13.5
Prop In Lane	0.04		0.13	1.00		1.00	1.00		0.41	1.00		0.04
Lane Grp Cap(c), veh/h	449	0	354	225	374	318	439	0	1004	367	0	1001
V/C Ratio(X)	0.42	0.00	0.47	0.32	0.20	0.39	0.04	0.00	0.62	0.69	0.00	0.54
Avail Cap(c_a), veh/h	449	0	354	225	374	318	439	0	1004	367	0	1001
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	0.00	1.00	1.00	1.00	1.00	1.00	0.00	1.00	1.00	0.00	1.00
Uniform Delay (d), s/veh	23.3	0.0	23.4	28.4	21.8	22.8	12.6	0.0	8.9	21.7	0.0	8.3
Incr Delay (d2), s/veh	0.6	0.0	1.0	0.8	0.3	0.8	0.0	0.0	1.1	5.3	0.0	0.6
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	3.2	0.0	2.9	1.3	1.2	2.1	0.2	0.0	7.7	5.2	0.0	6.4
LnGrp Delay(d),s/veh	24.0	0.0	24.3	29.2	22.1	23.6	12.7	0.0	10.0	26.9	0.0	8.9
LnGrp LOS	C		C	C	C	C	B		B	C		A
Approach Vol, veh/h		355			270			638			796	
Approach Delay, s/veh		24.1			24.7			10.1			14.6	
Approach LOS		C			C			B			B	

Timer	1	2	3	4	5	6	7	8
Assigned Phs		2		4		6		8
Phs Duration (G+Y+Rc), s		48.0		22.0		48.0		22.0
Change Period (Y+Rc), s		6.0		6.0		6.0		6.0
Max Green Setting (Gmax), s		42.0		16.0		42.0		16.0
Max Q Clear Time (g_c+I1), s		42.2		13.7		18.4		8.6
Green Ext Time (p_c), s		0.0		0.8		10.8		2.1

Intersection Summary	
HCM 2010 Ctrl Delay	16.2
HCM 2010 LOS	B

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	31	70	25	241	222	294	25	506	108	103	398	15
Number	3	8	18	7	4	14	1	6	16	5	2	12
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1900	1743	1900	1681	1681	1681	1810	1810	1900	1712	1712	1900
Adj Flow Rate, veh/h	34	78	28	268	247	327	28	562	120	114	442	17
Adj No. of Lanes	0	2	0	1	1	1	1	1	0	1	1	0
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Percent Heavy Veh, %	9	9	9	13	13	13	5	5	5	11	11	11
Cap, veh/h	192	442	174	431	531	452	398	731	156	240	828	32
Arrive On Green	0.32	0.32	0.32	0.32	0.32	0.32	0.51	0.51	0.51	0.51	0.51	0.51
Sat Flow, veh/h	350	1397	552	1158	1681	1429	902	1446	309	694	1638	63
Grp Volume(v), veh/h	64	0	76	268	247	327	28	0	682	114	0	459
Grp Sat Flow(s),veh/h/ln	810	0	1489	1158	1681	1429	902	0	1755	694	0	1701
Q Serve(g_s), s	0.4	0.0	2.5	14.6	7.9	13.6	1.5	0.0	21.1	10.7	0.0	12.3
Cycle Q Clear(g_c), s	8.3	0.0	2.5	17.0	7.9	13.6	13.7	0.0	21.1	31.8	0.0	12.3
Prop In Lane	0.53		0.37	1.00		1.00	1.00		0.18	1.00		0.04
Lane Grp Cap(c), veh/h	338	0	471	431	531	452	398	0	887	240	0	859
V/C Ratio(X)	0.19	0.00	0.16	0.62	0.46	0.72	0.07	0.00	0.77	0.48	0.00	0.53
Avail Cap(c_a), veh/h	381	0	532	478	601	511	399	0	888	240	0	861
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	0.00	1.00	1.00	1.00	1.00	1.00	0.00	1.00	1.00	0.00	1.00
Uniform Delay (d), s/veh	16.6	0.0	16.6	22.7	18.4	20.4	15.9	0.0	13.4	26.3	0.0	11.3
Incr Delay (d2), s/veh	0.3	0.0	0.2	2.1	0.6	4.4	0.1	0.0	4.1	1.5	0.0	0.6
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	0.9	0.0	1.0	4.9	3.7	5.9	0.4	0.0	11.1	2.1	0.0	5.9
LnGrp Delay(d),s/veh	16.9	0.0	16.7	24.8	19.1	24.8	16.0	0.0	17.6	27.8	0.0	11.9
LnGrp LOS	B		B	C	B	C	B		B	C		B
Approach Vol, veh/h		140			842			710			573	
Approach Delay, s/veh		16.8			23.1			17.5			15.1	
Approach LOS		B			C			B			B	

Timer	1	2	3	4	5	6	7	8
Assigned Phs		2		4		6		8
Phs Duration (G+Y+Rc), s		40.0		27.2		40.0		27.2
Change Period (Y+Rc), s		6.0		6.0		6.0		6.0
Max Green Setting (Gmax), s		34.0		24.0		34.0		24.0
Max Q Clear Time (g_c+I1), s		33.8		19.0		23.1		10.3
Green Ext Time (p_c), s		0.1		2.2		6.0		4.2

Intersection Summary	
HCM 2010 Ctrl Delay	18.9
HCM 2010 LOS	B

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	16	4	14	21	5	35	8	612	34	52	538	10
Number	7	4	14	3	8	18	5	2	12	1	6	16
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1667	1667	1900	1863	1863	1900	1792	1792	1900	1792	1792	1900
Adj Flow Rate, veh/h	18	4	16	23	6	39	9	680	38	58	598	11
Adj No. of Lanes	1	2	0	1	2	0	1	1	0	1	1	0
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Percent Heavy Veh, %	14	14	14	2	2	2	6	6	6	6	6	6
Cap, veh/h	362	348	312	412	389	348	403	978	55	328	1021	19
Arrive On Green	0.22	0.22	0.22	0.22	0.22	0.22	0.58	0.58	0.58	0.58	0.58	0.58
Sat Flow, veh/h	1213	1583	1417	1386	1770	1583	778	1682	94	703	1754	32
Grp Volume(v), veh/h	18	4	16	23	6	39	9	0	718	58	0	609
Grp Sat Flow(s),veh/h/ln	1213	1583	1417	1386	1770	1583	778	0	1776	703	0	1787
Q Serve(g_s), s	0.7	0.1	0.5	0.8	0.2	1.2	0.4	0.0	17.2	3.8	0.0	13.1
Cycle Q Clear(g_c), s	1.9	0.1	0.5	1.3	0.2	1.2	13.5	0.0	17.2	21.0	0.0	13.1
Prop In Lane	1.00		1.00	1.00		1.00	1.00		0.05	1.00		0.02
Lane Grp Cap(c), veh/h	362	348	312	412	389	348	403	0	1033	328	0	1039
V/C Ratio(X)	0.05	0.01	0.05	0.06	0.02	0.11	0.02	0.00	0.69	0.18	0.00	0.59
Avail Cap(c_a), veh/h	416	419	375	473	468	419	748	0	1820	640	0	1831
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.00	1.00	1.00	0.00	1.00
Uniform Delay (d), s/veh	19.6	18.5	18.6	19.2	18.5	18.9	12.3	0.0	8.9	16.3	0.0	8.0
Incr Delay (d2), s/veh	0.1	0.0	0.1	0.1	0.0	0.1	0.0	0.0	0.9	0.3	0.0	0.5
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	0.3	0.1	0.2	0.3	0.1	0.5	0.1	0.0	8.4	0.8	0.0	6.6
LnGrp Delay(d),s/veh	19.7	18.5	18.7	19.2	18.5	19.0	12.3	0.0	9.7	16.5	0.0	8.6
LnGrp LOS	B	B	B	B	B	B	B		A	B		A
Approach Vol, veh/h		38			68			727			667	
Approach Delay, s/veh		19.1			19.0			9.8			9.2	
Approach LOS		B			B			A			A	

Timer	1	2	3	4	5	6	7	8
Assigned Phs		2		4		6		8
Phs Duration (G+Y+Rc), s		41.2		19.3		41.2		19.3
Change Period (Y+Rc), s		6.0		6.0		6.0		6.0
Max Green Setting (Gmax), s		62.0		16.0		62.0		16.0
Max Q Clear Time (g_c+I1), s		19.2		3.9		23.0		3.3
Green Ext Time (p_c), s		12.5		0.3		12.2		0.3

Intersection Summary	
HCM 2010 Ctrl Delay	10.2
HCM 2010 LOS	B

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	13	8	7	30	4	46	14	484	25	30	526	9
Number	7	4	14	3	8	18	5	2	12	1	6	16
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1712	1712	1900	1863	1863	1900	1792	1792	1900	1810	1810	1900
Adj Flow Rate, veh/h	14	9	8	33	4	51	16	538	28	33	584	10
Adj No. of Lanes	1	2	0	1	2	0	1	1	0	1	1	0
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Percent Heavy Veh, %	11	11	11	2	2	2	6	6	6	5	5	5
Cap, veh/h	434	452	351	498	458	410	346	845	44	362	888	15
Arrive On Green	0.26	0.26	0.26	0.26	0.26	0.26	0.50	0.50	0.50	0.50	0.50	0.50
Sat Flow, veh/h	1234	1744	1355	1390	1770	1583	789	1689	88	817	1774	30
Grp Volume(v), veh/h	14	8	9	33	4	51	16	0	566	33	0	594
Grp Sat Flow(s),veh/h/ln	1234	1626	1473	1390	1770	1583	789	0	1777	817	0	1804
Q Serve(g_s), s	0.4	0.2	0.2	0.9	0.1	1.2	0.8	0.0	11.6	1.5	0.0	12.2
Cycle Q Clear(g_c), s	1.7	0.2	0.2	1.1	0.1	1.2	13.0	0.0	11.6	13.2	0.0	12.2
Prop In Lane	1.00		0.92	1.00		1.00	1.00		0.05	1.00		0.02
Lane Grp Cap(c), veh/h	434	421	382	498	458	410	346	0	889	362	0	903
V/C Ratio(X)	0.03	0.02	0.02	0.07	0.01	0.12	0.05	0.00	0.64	0.09	0.00	0.66
Avail Cap(c_a), veh/h	559	587	531	640	639	571	900	0	2137	937	0	2170
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.00	1.00	1.00	0.00	1.00
Uniform Delay (d), s/veh	14.8	13.8	13.8	14.2	13.7	14.1	14.1	0.0	9.1	14.0	0.0	9.3
Incr Delay (d2), s/veh	0.0	0.0	0.0	0.1	0.0	0.1	0.1	0.0	0.8	0.1	0.0	0.8
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	0.2	0.1	0.1	0.4	0.0	0.6	0.2	0.0	5.8	0.4	0.0	6.1
LnGrp Delay(d),s/veh	14.8	13.8	13.8	14.2	13.7	14.3	14.2	0.0	9.9	14.1	0.0	10.1
LnGrp LOS	B	B	B	B	B	B	B		A	B		B
Approach Vol, veh/h		31			88			582			627	
Approach Delay, s/veh		14.3			14.2			10.0			10.3	
Approach LOS		B			B			B			B	

Timer	1	2	3	4	5	6	7	8
Assigned Phs		2		4		6		8
Phs Duration (G+Y+Rc), s		31.0		18.9		31.0		18.9
Change Period (Y+Rc), s		6.0		6.0		6.0		6.0
Max Green Setting (Gmax), s		60.0		18.0		60.0		18.0
Max Q Clear Time (g_c+I1), s		15.0		3.7		15.2		3.2
Green Ext Time (p_c), s		9.8		0.4		9.8		0.4

Intersection Summary	
HCM 2010 Ctrl Delay	10.5
HCM 2010 LOS	B

Intersection	
Int Delay, s/veh	6.5

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Vol, veh/h	229	584	309	38	44	155
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	-	-	-	-	0	-
Veh in Median Storage, #	-	0	0	-	0	-
Grade, %	-	0	0	-	0	-
Peak Hour Factor	90	90	90	90	90	90
Heavy Vehicles, %	4	4	6	6	2	2
Mvmt Flow	254	649	343	42	49	172

Major/Minor	Major1		Major2		Minor2	
Conflicting Flow All	386	0	-	0	1197	193
Stage 1	-	-	-	-	364	-
Stage 2	-	-	-	-	833	-
Critical Hdwy	4.18	-	-	-	6.84	6.94
Critical Hdwy Stg 1	-	-	-	-	5.84	-
Critical Hdwy Stg 2	-	-	-	-	5.84	-
Follow-up Hdwy	2.24	-	-	-	3.52	3.32
Pot Cap-1 Maneuver	1155	-	-	-	179	816
Stage 1	-	-	-	-	673	-
Stage 2	-	-	-	-	387	-
Platoon blocked, %		-	-	-		
Mov Cap-1 Maneuver	1155	-	-	-	117	816
Mov Cap-2 Maneuver	-	-	-	-	117	-
Stage 1	-	-	-	-	673	-
Stage 2	-	-	-	-	254	-

Approach	EB	WB	SB
HCM Control Delay, s	3.2		31
HCM LOS			D

Minor Lane/Major Mvmt	EBL	EBT	WBT	WBR	SBLn1
Capacity (veh/h)	1155	-	-	-	352
HCM Lane V/C Ratio	0.22	-	-	-	0.628
HCM Control Delay (s)	9	0.9	-	-	31
HCM Lane LOS	A	A	-	-	D
HCM 95th %tile Q(veh)	1	-	-	-	4

Intersection	
Int Delay, s/veh	5.8

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Vol, veh/h	157	281	551	53	25	238
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Stop	Stop
RT Channelized	-	None	-	None	-	None
Storage Length	-	-	-	-	0	-
Veh in Median Storage, #	-	0	0	-	0	-
Grade, %	-	0	0	-	0	-
Peak Hour Factor	90	90	90	90	90	90
Heavy Vehicles, %	3	3	5	5	2	2
Mvmt Flow	174	312	612	59	28	264

Major/Minor	Major1		Major2		Minor2	
Conflicting Flow All	671	0	-	0	1147	336
Stage 1	-	-	-	-	642	-
Stage 2	-	-	-	-	505	-
Critical Hdwy	4.16	-	-	-	6.84	6.94
Critical Hdwy Stg 1	-	-	-	-	5.84	-
Critical Hdwy Stg 2	-	-	-	-	5.84	-
Follow-up Hdwy	2.23	-	-	-	3.52	3.32
Pot Cap-1 Maneuver	909	-	-	-	192	660
Stage 1	-	-	-	-	486	-
Stage 2	-	-	-	-	571	-
Platoon blocked, %		-	-	-		
Mov Cap-1 Maneuver	909	-	-	-	147	660
Mov Cap-2 Maneuver	-	-	-	-	147	-
Stage 1	-	-	-	-	486	-
Stage 2	-	-	-	-	439	-

Approach	EB	WB	SB
HCM Control Delay, s	3.9		22.1
HCM LOS			C

Minor Lane/Major Mvmt	EBL	EBT	WBT	WBR	SBLn1
Capacity (veh/h)	909	-	-	-	496
HCM Lane V/C Ratio	0.192	-	-	-	0.589
HCM Control Delay (s)	9.9	0.5	-	-	22.1
HCM Lane LOS	A	A	-	-	C
HCM 95th %tile Q(veh)	1	-	-	-	4

Intersection	
Int Delay, s/veh	9.1

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR
Vol, veh/h	348	234	4	7	102	50	4	5	8
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Free	Free	Stop	Stop	Stop
RT Channelized	-	-	None	-	-	None	-	-	None
Storage Length	-	-	-	-	-	-	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-
Peak Hour Factor	90	90	90	90	90	90	90	90	90
Heavy Vehicles, %	6	6	6	5	5	5	2	2	2
Mvmt Flow	387	260	4	8	113	56	4	6	9

Major/Minor	Major1			Major2			Minor1		
Conflicting Flow All	169	0	0	264	0	0	1110	1220	132
Stage 1	-	-	-	-	-	-	1036	1036	-
Stage 2	-	-	-	-	-	-	74	184	-
Critical Hdwy	4.22	-	-	4.2	-	-	7.54	6.54	6.94
Critical Hdwy Stg 1	-	-	-	-	-	-	6.54	5.54	-
Critical Hdwy Stg 2	-	-	-	-	-	-	6.54	5.54	-
Follow-up Hdwy	2.26	-	-	2.25	-	-	3.52	4.02	3.32
Pot Cap-1 Maneuver	1377	-	-	1276	-	-	164	179	893
Stage 1	-	-	-	-	-	-	248	307	-
Stage 2	-	-	-	-	-	-	927	746	-
Platoon blocked, %		-	-		-	-			
Mov Cap-1 Maneuver	1377	-	-	1276	-	-	87	119	893
Mov Cap-2 Maneuver	-	-	-	-	-	-	87	119	-
Stage 1	-	-	-	-	-	-	166	206	-
Stage 2	-	-	-	-	-	-	671	741	-

Approach	EB	WB	NB
HCM Control Delay, s			28
HCM LOS			D

Minor Lane/Major Mvmt	NBLn1	EBL	EBT	EBR	WBL	WBT	WBR	SBLn1	SBLn2
Capacity (veh/h)	175	1377	-	-	1276	-	-	122	946
HCM Lane V/C Ratio	0.108	0.281	-	-	0.006	-	-	0.719	0.267
HCM Control Delay (s)	28	8.6	0.4	-	7.8	0	-	87.7	10.2
HCM Lane LOS	D	A	A	-	A	A	-	F	B
HCM 95th %tile Q(veh)	0	1	-	-	0	-	-	4	1

Intersection			
Int Delay, s/veh			

Movement	SBL	SBT	SBR
Vol, veh/h	75	4	227
Conflicting Peds, #/hr	0	0	0
Sign Control	Stop	Stop	Stop
RT Channelized	-	-	None
Storage Length	-	-	0
Veh in Median Storage, #	-	0	-
Grade, %	-	0	-
Peak Hour Factor	90	90	90
Heavy Vehicles, %	6	6	6
Mvmt Flow	83	4	252

Major/Minor	Minor2		
Conflicting Flow All	1063	1195	84
Stage 1	157	157	-
Stage 2	906	1038	-
Critical Hdwy	7.62	6.62	7.02
Critical Hdwy Stg 1	6.62	5.62	-
Critical Hdwy Stg 2	6.62	5.62	-
Follow-up Hdwy	3.56	4.06	3.36
Pot Cap-1 Maneuver	172	179	946
Stage 1	818	757	-
Stage 2	289	298	-
Platoon blocked, %			
Mov Cap-1 Maneuver	122	119	946
Mov Cap-2 Maneuver	122	119	-
Stage 1	548	752	-
Stage 2	187	200	-

Approach	SB
HCM Control Delay, s	30.2
HCM LOS	D

Minor Lane/Major Mvmt

Intersection	
Int Delay, s/veh	7.8

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR
Vol, veh/h	252	102	4	6	281	69	4	8	4
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0
Sign Control	Free	Free	Free	Free	Free	Free	Stop	Stop	Stop
RT Channelized	-	-	None	-	-	None	-	-	None
Storage Length	-	-	-	-	-	-	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-
Peak Hour Factor	90	90	90	90	90	90	90	90	90
Heavy Vehicles, %	5	5	5	4	4	4	2	2	2
Mvmt Flow	280	113	4	7	312	77	4	9	4

Major/Minor	Major1			Major2			Minor1		
Conflicting Flow All	389	0	0	118	0	0	849	1078	59
Stage 1	-	-	-	-	-	-	676	676	-
Stage 2	-	-	-	-	-	-	173	402	-
Critical Hdwy	4.2	-	-	4.18	-	-	7.54	6.54	6.94
Critical Hdwy Stg 1	-	-	-	-	-	-	6.54	5.54	-
Critical Hdwy Stg 2	-	-	-	-	-	-	6.54	5.54	-
Follow-up Hdwy	2.25	-	-	2.24	-	-	3.52	4.02	3.32
Pot Cap-1 Maneuver	1145	-	-	1453	-	-	254	217	994
Stage 1	-	-	-	-	-	-	409	451	-
Stage 2	-	-	-	-	-	-	812	599	-
Platoon blocked, %		-	-		-	-			
Mov Cap-1 Maneuver	1145	-	-	1453	-	-	100	159	994
Mov Cap-2 Maneuver	-	-	-	-	-	-	100	159	-
Stage 1	-	-	-	-	-	-	302	333	-
Stage 2	-	-	-	-	-	-	411	595	-

Approach	EB	WB	NB
HCM Control Delay, s			28.6
HCM LOS			D

Minor Lane/Major Mvmt	NBLn1	EBL	EBT	EBR	WBL	WBT	WBR	SBLn1	SBLn2
Capacity (veh/h)	170	1145	-	-	1453	-	-	151	805
HCM Lane V/C Ratio	0.105	0.245	-	-	0.005	-	-	0.53	0.484
HCM Control Delay (s)	28.6	9.2	0.2	-	7.5	0	-	53	13.6
HCM Lane LOS	D	A	A	-	A	A	-	F	B
HCM 95th %tile Q(veh)	0	1	-	-	0	-	-	3	3

Intersection			
Int Delay, s/veh			

Movement	SBL	SBT	SBR
Vol, veh/h	65	7	351
Conflicting Peds, #/hr	0	0	0
Sign Control	Stop	Stop	Stop
RT Channelized	-	-	None
Storage Length	-	-	0
Veh in Median Storage, #	-	0	-
Grade, %	-	0	-
Peak Hour Factor	90	90	90
Heavy Vehicles, %	5	5	5
Mvmt Flow	72	8	390

Major/Minor	Minor2		
Conflicting Flow All	985	1042	194
Stage 1	364	364	-
Stage 2	621	678	-
Critical Hdwy	7.6	6.6	7
Critical Hdwy Stg 1	6.6	5.6	-
Critical Hdwy Stg 2	6.6	5.6	-
Follow-up Hdwy	3.55	4.05	3.35
Pot Cap-1 Maneuver	198	223	805
Stage 1	619	615	-
Stage 2	434	443	-
Platoon blocked, %			
Mov Cap-1 Maneuver	150	164	805
Mov Cap-2 Maneuver	150	164	-
Stage 1	457	611	-
Stage 2	310	327	-

Approach	SB
HCM Control Delay, s	20.3
HCM LOS	C

Minor Lane/Major Mvmt

Intersection	
Int Delay, s/veh	5.3

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR
Vol, veh/h	30	4	283	5	5	4	135	51	7
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0
Sign Control	Stop	Stop	Stop	Stop	Stop	Stop	Free	Free	Free
RT Channelized	-	-	None	-	-	None	-	-	None
Storage Length	-	-	0	-	-	-	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-
Peak Hour Factor	90	90	90	90	90	90	90	90	90
Heavy Vehicles, %	5	5	5	2	2	2	4	4	4
Mvmt Flow	33	4	314	6	6	4	150	57	8

Major/Minor	Minor2			Minor1			Major1		
Conflicting Flow All	543	576	107	468	583	32	213	0	0
Stage 1	212	212	-	361	361	-	-	-	-
Stage 2	331	364	-	107	222	-	-	-	-
Critical Hdwy	7.6	6.6	7	7.54	6.54	6.94	4.18	-	-
Critical Hdwy Stg 1	6.6	5.6	-	6.54	5.54	-	-	-	-
Critical Hdwy Stg 2	6.6	5.6	-	6.54	5.54	-	-	-	-
Follow-up Hdwy	3.55	4.05	3.35	3.52	4.02	3.32	2.24	-	-
Pot Cap-1 Maneuver	416	420	917	478	423	1035	1340	-	-
Stage 1	762	718	-	630	624	-	-	-	-
Stage 2	648	615	-	887	718	-	-	-	-
Platoon blocked, %								-	-
Mov Cap-1 Maneuver	372	370	917	283	373	1035	1340	-	-
Mov Cap-2 Maneuver	372	370	-	283	373	-	-	-	-
Stage 1	674	716	-	557	552	-	-	-	-
Stage 2	565	544	-	577	716	-	-	-	-

Approach	EB	WB	NB
HCM Control Delay, s	11.5	14.3	
HCM LOS	B	B	

Minor Lane/Major Mvmt	NBL	NBT	NBR	EBLn1	EBLn2	WBLn1	SBL	SBT	SBR
Capacity (veh/h)	1340	-	-	372	917	401	1515	-	-
HCM Lane V/C Ratio	0.112	-	-	0.102	0.343	0.039	0.003	-	-
HCM Control Delay (s)	8	0.1	-	15.8	11	14.3	7.4	0	-
HCM Lane LOS	A	A	-	C	B	B	A	A	-
HCM 95th %tile Q(veh)	0	-	-	0	2	0	0	-	-

Intersection	
Int Delay, s/veh	

Movement	SBL	SBT	SBR
Vol, veh/h	4	173	19
Conflicting Peds, #/hr	0	0	0
Sign Control	Free	Free	Free
RT Channelized	-	-	None
Storage Length	-	-	-
Veh in Median Storage, #	-	0	-
Grade, %	-	0	-
Peak Hour Factor	90	90	90
Heavy Vehicles, %	5	5	5
Mvmt Flow	4	192	21

Major/Minor	Major2		
Conflicting Flow All	64	0	0
Stage 1	-	-	-
Stage 2	-	-	-
Critical Hdwy	4.2	-	-
Critical Hdwy Stg 1	-	-	-
Critical Hdwy Stg 2	-	-	-
Follow-up Hdwy	2.25	-	-
Pot Cap-1 Maneuver	1515	-	-
Stage 1	-	-	-
Stage 2	-	-	-
Platoon blocked, %		-	-
Mov Cap-1 Maneuver	1515	-	-
Mov Cap-2 Maneuver	-	-	-
Stage 1	-	-	-
Stage 2	-	-	-

Approach	SB
HCM Control Delay, s	
HCM LOS	

Minor Lane/Major Mvmt

Intersection	
Int Delay, s/veh	3.3

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR
Vol, veh/h	29	4	138	6	4	4	282	140	6
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0
Sign Control	Stop	Stop	Stop	Stop	Stop	Stop	Free	Free	Free
RT Channelized	-	-	None	-	-	None	-	-	None
Storage Length	-	-	0	-	-	-	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-
Peak Hour Factor	90	90	90	90	90	90	90	90	90
Heavy Vehicles, %	4	4	4	2	2	2	3	3	3
Mvmt Flow	32	4	153	7	4	4	313	156	7

Major/Minor	Minor2			Minor1			Major1		
Conflicting Flow All	840	922	71	851	958	81	141	0	0
Stage 1	133	133	-	786	786	-	-	-	-
Stage 2	707	789	-	65	172	-	-	-	-
Critical Hdwy	7.58	6.58	6.98	7.54	6.54	6.94	4.16	-	-
Critical Hdwy Stg 1	6.58	5.58	-	6.54	5.54	-	-	-	-
Critical Hdwy Stg 2	6.58	5.58	-	6.54	5.54	-	-	-	-
Follow-up Hdwy	3.54	4.04	3.34	3.52	4.02	3.32	2.23	-	-
Pot Cap-1 Maneuver	255	265	971	253	256	963	1432	-	-
Stage 1	851	781	-	351	401	-	-	-	-
Stage 2	388	395	-	938	755	-	-	-	-
Platoon blocked, %								-	-
Mov Cap-1 Maneuver	201	199	971	169	192	963	1432	-	-
Mov Cap-2 Maneuver	201	199	-	169	192	-	-	-	-
Stage 1	647	771	-	267	305	-	-	-	-
Stage 2	289	300	-	775	745	-	-	-	-

Approach	EB	WB	NB
HCM Control Delay, s	12.8	21.7	
HCM LOS	B	C	

Minor Lane/Major Mvmt	NBL	NBT	NBR	EBLn1	EBLn2	WBLn1	SBL	SBT	SBR
Capacity (veh/h)	1432	-	-	201	971	231	1400	-	-
HCM Lane V/C Ratio	0.219	-	-	0.182	0.158	0.067	0.011	-	-
HCM Control Delay (s)	8.2	0.2	-	26.9	9.4	21.7	7.6	0	-
HCM Lane LOS	A	A	-	D	A	C	A	A	-
HCM 95th %tile Q(veh)	1	-	-	1	1	0	0	-	-

Intersection	
Int Delay, s/veh	

Movement	SBL	SBT	SBR
Vol, veh/h	14	57	70
Conflicting Peds, #/hr	0	0	0
Sign Control	Free	Free	Free
RT Channelized	-	-	None
Storage Length	-	-	-
Veh in Median Storage, #	-	0	-
Grade, %	-	0	-
Peak Hour Factor	90	90	90
Heavy Vehicles, %	4	4	4
Mvmt Flow	16	63	78

Major/Minor	Major2		
Conflicting Flow All	162	0	0
Stage 1	-	-	-
Stage 2	-	-	-
Critical Hdwy	4.18	-	-
Critical Hdwy Stg 1	-	-	-
Critical Hdwy Stg 2	-	-	-
Follow-up Hdwy	2.24	-	-
Pot Cap-1 Maneuver	1400	-	-
Stage 1	-	-	-
Stage 2	-	-	-
Platoon blocked, %		-	-
Mov Cap-1 Maneuver	1400	-	-
Mov Cap-2 Maneuver	-	-	-
Stage 1	-	-	-
Stage 2	-	-	-

Approach	SB
HCM Control Delay, s	
HCM LOS	

Minor Lane/Major Mvmt

Intersection	
Intersection Delay, s/veh	24.7
Intersection LOS	C

Movement	EBU	EBL	EBT	EBR	WBU	WBL	WBT	WBR	NBU	NBL	NBT	NBR
Vol, veh/h	0	35	8	104	0	14	6	44	0	206	162	12
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Heavy Vehicles, %	2	2	2	2	2	2	2	2	2	6	6	6
Mvmt Flow	0	39	9	116	0	16	7	49	0	229	180	13
Number of Lanes	0	0	1	0	0	0	1	1	0	0	1	1

Approach	EB	WB	NB
Opposing Approach	WB	EB	SB
Opposing Lanes	2	1	1
Conflicting Approach Left	SB	NB	EB
Conflicting Lanes Left	1	2	1
Conflicting Approach Right	NB	SB	WB
Conflicting Lanes Right	2	1	2
HCM Control Delay	13.4	10.7	24.1
HCM LOS	B	B	C

Lane	NBLn1	NBLn2	EBLn1	WBLn1	WBLn2	SBLn1
Vol Left, %	56%	0%	24%	70%	0%	31%
Vol Thru, %	44%	0%	5%	30%	0%	48%
Vol Right, %	0%	100%	71%	0%	100%	20%
Sign Control	Stop	Stop	Stop	Stop	Stop	Stop
Traffic Vol by Lane	368	12	147	20	44	435
LT Vol	162	0	8	6	0	210
Through Vol	0	12	104	0	44	88
RT Vol	206	0	35	14	0	137
Lane Flow Rate	409	13	163	22	49	483
Geometry Grp	7	7	6	7	7	6
Degree of Util (X)	0.727	0.02	0.321	0.05	0.095	0.818
Departure Headway (Hd)	6.4	5.405	7.079	8.095	7.014	6.09
Convergence, Y/N	Yes	Yes	Yes	Yes	Yes	Yes
Cap	560	656	511	445	513	590
Service Time	4.19	3.193	5.083	5.804	4.723	4.176
HCM Lane V/C Ratio	0.73	0.02	0.319	0.049	0.096	0.819
HCM Control Delay	24.6	8.3	13.4	11.2	10.5	31.1
HCM Lane LOS	C	A	B	B	B	D
HCM 95th-tile Q	6.1	0.1	1.4	0.2	0.3	8.3

Intersection	
Intersection Delay, s/veh	
Intersection LOS	

Movement	SBU	SBL	SBT	SBR
Vol, veh/h	0	137	210	88
Peak Hour Factor	0.90	0.90	0.90	0.90
Heavy Vehicles, %	2	4	4	4
Mvmt Flow	0	152	233	98
Number of Lanes	0	0	1	0

Approach	SB
Opposing Approach	NB
Opposing Lanes	2
Conflicting Approach Left	WB
Conflicting Lanes Left	2
Conflicting Approach Right	EB
Conflicting Lanes Right	1
HCM Control Delay	31.1
HCM LOS	D

Lane

Intersection	
Intersection Delay, s/veh	25.3
Intersection LOS	D

Movement	EBU	EBL	EBT	EBR	WBU	WBL	WBT	WBR	NBU	NBL	NBT	NBR
Vol, veh/h	0	59	12	201	0	7	9	163	0	145	215	15
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Heavy Vehicles, %	2	2	2	2	2	2	2	2	2	5	5	5
Mvmt Flow	0	66	13	223	0	8	10	181	0	161	239	17
Number of Lanes	0	0	1	0	0	0	1	1	0	0	1	1

Approach	EB	WB	NB
Opposing Approach	WB	EB	SB
Opposing Lanes	2	1	1
Conflicting Approach Left	SB	NB	EB
Conflicting Lanes Left	1	2	1
Conflicting Approach Right	NB	SB	WB
Conflicting Lanes Right	2	1	2
HCM Control Delay	21.9	14.1	34.6
HCM LOS	C	B	D

Lane	NBLn1	NBLn2	EBLn1	WBLn1	WBLn2	SBLn1
Vol Left, %	40%	0%	22%	44%	0%	15%
Vol Thru, %	60%	0%	4%	56%	0%	70%
Vol Right, %	0%	100%	74%	0%	100%	15%
Sign Control	Stop	Stop	Stop	Stop	Stop	Stop
Traffic Vol by Lane	360	15	272	16	163	276
LT Vol	215	0	12	9	0	193
Through Vol	0	15	201	0	163	42
RT Vol	145	0	59	7	0	41
Lane Flow Rate	400	17	302	18	181	307
Geometry Grp	7	7	6	7	7	6
Degree of Util (X)	0.816	0.03	0.622	0.041	0.37	0.643
Departure Headway (Hd)	7.482	6.558	7.408	8.313	7.364	7.548
Convergence, Y/N	Yes	Yes	Yes	Yes	Yes	Yes
Cap	488	549	490	432	489	478
Service Time	5.182	4.258	5.436	6.044	5.095	5.58
HCM Lane V/C Ratio	0.82	0.031	0.616	0.042	0.37	0.642
HCM Control Delay	35.6	9.5	21.9	11.4	14.4	23.2
HCM Lane LOS	E	A	C	B	B	C
HCM 95th-tile Q	7.8	0.1	4.2	0.1	1.7	4.5

Intersection	
Intersection Delay, s/veh	
Intersection LOS	

Movement	SBU	SBL	SBT	SBR
Vol, veh/h	0	41	193	42
Peak Hour Factor	0.90	0.90	0.90	0.90
Heavy Vehicles, %	2	3	3	3
Mvmt Flow	0	46	214	47
Number of Lanes	0	0	1	0

Approach	SB
Opposing Approach	NB
Opposing Lanes	2
Conflicting Approach Left	WB
Conflicting Lanes Left	2
Conflicting Approach Right	EB
Conflicting Lanes Right	1
HCM Control Delay	23.2
HCM LOS	C

Lane

Intersection	
Int Delay, s/veh	1.1

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Vol, veh/h	7	20	201	7	62	420
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	0	-	-	-	-	-
Veh in Median Storage, #	0	-	0	-	-	0
Grade, %	0	-	0	-	-	0
Peak Hour Factor	90	90	90	90	90	90
Heavy Vehicles, %	16	16	4	4	5	5
Mvmt Flow	8	22	223	8	69	467

Major/Minor	Minor1		Major1		Major2	
Conflicting Flow All	831	227	0	0	231	0
Stage 1	227	-	-	-	-	-
Stage 2	604	-	-	-	-	-
Critical Hdwy	6.56	6.36	-	-	4.15	-
Critical Hdwy Stg 1	5.56	-	-	-	-	-
Critical Hdwy Stg 2	5.56	-	-	-	-	-
Follow-up Hdwy	3.644	3.444	-	-	2.245	-
Pot Cap-1 Maneuver	321	779	-	-	1319	-
Stage 1	779	-	-	-	-	-
Stage 2	520	-	-	-	-	-
Platoon blocked, %			-	-		-
Mov Cap-1 Maneuver	298	779	-	-	1319	-
Mov Cap-2 Maneuver	298	-	-	-	-	-
Stage 1	779	-	-	-	-	-
Stage 2	483	-	-	-	-	-

Approach	WB	NB	SB
HCM Control Delay, s	11.9		1
HCM LOS	B		

Minor Lane/Major Mvmt	NBT	NBR	WBLn1	SBL	SBT
Capacity (veh/h)	-	-	549	1319	-
HCM Lane V/C Ratio	-	-	0.055	0.052	-
HCM Control Delay (s)	-	-	11.9	7.9	0
HCM Lane LOS	-	-	B	A	A
HCM 95th %tile Q(veh)	-	-	0	0	-

Intersection	
Int Delay, s/veh	2.1

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Vol, veh/h	18	86	450	18	22	222
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	0	-	-	-	-	-
Veh in Median Storage, #	0	-	0	-	-	0
Grade, %	0	-	0	-	-	0
Peak Hour Factor	90	90	90	90	90	90
Heavy Vehicles, %	8	8	3	3	4	4
Mvmt Flow	20	96	500	20	24	247

Major/Minor	Minor1		Major1		Major2	
Conflicting Flow All	806	510	0	0	520	0
Stage 1	510	-	-	-	-	-
Stage 2	296	-	-	-	-	-
Critical Hdwy	6.48	6.28	-	-	4.14	-
Critical Hdwy Stg 1	5.48	-	-	-	-	-
Critical Hdwy Stg 2	5.48	-	-	-	-	-
Follow-up Hdwy	3.572	3.372	-	-	2.236	-
Pot Cap-1 Maneuver	343	552	-	-	1036	-
Stage 1	591	-	-	-	-	-
Stage 2	741	-	-	-	-	-
Platoon blocked, %			-	-		-
Mov Cap-1 Maneuver	334	552	-	-	1036	-
Mov Cap-2 Maneuver	334	-	-	-	-	-
Stage 1	591	-	-	-	-	-
Stage 2	721	-	-	-	-	-

Approach	WB	NB	SB
HCM Control Delay, s	14.4		0.8
HCM LOS	B		

Minor Lane/Major Mvmt	NBT	NBR	WBLn1	SBL	SBT
Capacity (veh/h)	-	-	496	1036	-
HCM Lane V/C Ratio	-	-	0.233	0.024	-
HCM Control Delay (s)	-	-	14.4	8.6	0
HCM Lane LOS	-	-	B	A	A
HCM 95th %tile Q(veh)	-	-	1	0	-

Intersection	
Int Delay, s/veh	3.2

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Vol, veh/h	39	203	164	101	450	119
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	Free	-	None	-	None
Storage Length	0	100	-	-	0	-
Veh in Median Storage, #	0	-	0	-	-	0
Grade, %	0	-	0	-	-	0
Peak Hour Factor	90	90	90	90	90	90
Heavy Vehicles, %	5	5	11	11	10	10
Mvmt Flow	43	226	182	112	500	132

Major/Minor	Minor1		Major1		Major2	
Conflicting Flow All	1370	-	0	0	294	0
Stage 1	238	-	-	-	-	-
Stage 2	1132	-	-	-	-	-
Critical Hdwy	6.45	-	-	-	4.2	-
Critical Hdwy Stg 1	5.45	-	-	-	-	-
Critical Hdwy Stg 2	5.45	-	-	-	-	-
Follow-up Hdwy	3.545	-	-	-	2.29	-
Pot Cap-1 Maneuver	159	0	-	-	1223	-
Stage 1	795	0	-	-	-	-
Stage 2	304	0	-	-	-	-
Platoon blocked, %			-	-		-
Mov Cap-1 Maneuver	94	-	-	-	1223	-
Mov Cap-2 Maneuver	94	-	-	-	-	-
Stage 1	795	-	-	-	-	-
Stage 2	180	-	-	-	-	-

Approach	WB	NB	SB
HCM Control Delay, s	72.5		
HCM LOS	F		

Minor Lane/Major Mvmt	NBT	NBR	WBLn1	WBLn2	SBL	SBT
Capacity (veh/h)	-	-	94	-	1223	-
HCM Lane V/C Ratio	-	-	0.461	-	0.409	-
HCM Control Delay (s)	-	-	72.5	0	10	-
HCM Lane LOS	-	-	F	A	A	-
HCM 95th %tile Q(veh)	-	-	2	-	2	-

Intersection	
Int Delay, s/veh	1.7

Movement	WBL	WBR	NBT	NBR	SBL	SBT
Vol, veh/h	55	541	102	69	152	166
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	Free	-	None	-	None
Storage Length	0	100	-	-	0	-
Veh in Median Storage, #	0	-	0	-	-	0
Grade, %	0	-	0	-	-	0
Peak Hour Factor	90	90	90	90	90	90
Heavy Vehicles, %	4	4	10	10	8	8
Mvmt Flow	61	601	113	77	169	184

Major/Minor	Minor1		Major1		Major2	
Conflicting Flow All	674	-	0	0	190	0
Stage 1	152	-	-	-	-	-
Stage 2	522	-	-	-	-	-
Critical Hdwy	6.44	-	-	-	4.18	-
Critical Hdwy Stg 1	5.44	-	-	-	-	-
Critical Hdwy Stg 2	5.44	-	-	-	-	-
Follow-up Hdwy	3.536	-	-	-	2.272	-
Pot Cap-1 Maneuver	417	0	-	-	1349	-
Stage 1	871	0	-	-	-	-
Stage 2	591	0	-	-	-	-
Platoon blocked, %			-	-		-
Mov Cap-1 Maneuver	365	-	-	-	1349	-
Mov Cap-2 Maneuver	365	-	-	-	-	-
Stage 1	871	-	-	-	-	-
Stage 2	517	-	-	-	-	-

Approach	WB	NB	SB
HCM Control Delay, s	16.8		
HCM LOS	C		

Minor Lane/Major Mvmt	NBT	NBR	WBLn1	WBLn2	SBL	SBT
Capacity (veh/h)	-	-	365	-	1349	-
HCM Lane V/C Ratio	-	-	0.167	-	0.125	-
HCM Control Delay (s)	-	-	16.8	0	8.1	-
HCM Lane LOS	-	-	C	A	A	-
HCM 95th %tile Q(veh)	-	-	1	-	0	-

Intersection	
Int Delay, s/veh	5.3

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Vol, veh/h	102	120	79	254	431	53
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	0	-	150	-	-	-
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	90	90	90	90	90	90
Heavy Vehicles, %	2	2	10	10	14	14
Mvmt Flow	113	133	88	282	479	59

Major/Minor	Minor2		Major1		Major2	
Conflicting Flow All	825	269	538	0	-	0
Stage 1	508	-	-	-	-	-
Stage 2	317	-	-	-	-	-
Critical Hdwy	6.84	6.94	4.3	-	-	-
Critical Hdwy Stg 1	5.84	-	-	-	-	-
Critical Hdwy Stg 2	5.84	-	-	-	-	-
Follow-up Hdwy	3.52	3.32	2.3	-	-	-
Pot Cap-1 Maneuver	311	729	973	-	-	-
Stage 1	569	-	-	-	-	-
Stage 2	711	-	-	-	-	-
Platoon blocked, %				-	-	-
Mov Cap-1 Maneuver	283	729	973	-	-	-
Mov Cap-2 Maneuver	283	-	-	-	-	-
Stage 1	569	-	-	-	-	-
Stage 2	647	-	-	-	-	-

Approach	EB	NB	SB
HCM Control Delay, s	24.7		
HCM LOS	C		

Minor Lane/Major Mvmt	NBL	NBT	EBLn1	SBT	SBR
Capacity (veh/h)	973	-	423	-	-
HCM Lane V/C Ratio	0.09	-	0.583	-	-
HCM Control Delay (s)	9.1	-	24.7	-	-
HCM Lane LOS	A	-	C	-	-
HCM 95th %tile Q(veh)	0	-	4	-	-

Intersection	
Int Delay, s/veh	3.6

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Vol, veh/h	90	70	146	534	215	81
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	0	-	150	-	-	-
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	90	90	90	90	90	90
Heavy Vehicles, %	2	2	8	8	12	12
Mvmt Flow	100	78	162	593	239	90

Major/Minor	Minor2		Major1		Major2	
Conflicting Flow All	905	164	329	0	-	0
Stage 1	284	-	-	-	-	-
Stage 2	621	-	-	-	-	-
Critical Hdwy	6.84	6.94	4.26	-	-	-
Critical Hdwy Stg 1	5.84	-	-	-	-	-
Critical Hdwy Stg 2	5.84	-	-	-	-	-
Follow-up Hdwy	3.52	3.32	2.28	-	-	-
Pot Cap-1 Maneuver	276	852	1185	-	-	-
Stage 1	739	-	-	-	-	-
Stage 2	498	-	-	-	-	-
Platoon blocked, %				-	-	-
Mov Cap-1 Maneuver	238	852	1185	-	-	-
Mov Cap-2 Maneuver	238	-	-	-	-	-
Stage 1	739	-	-	-	-	-
Stage 2	430	-	-	-	-	-

Approach	EB	NB	SB
HCM Control Delay, s	25.7		
HCM LOS	D		

Minor Lane/Major Mvmt	NBL	NBT	EBLn1	SBT	SBR
Capacity (veh/h)	1185	-	348	-	-
HCM Lane V/C Ratio	0.137	-	0.511	-	-
HCM Control Delay (s)	8.5	-	25.7	-	-
HCM Lane LOS	A	-	D	-	-
HCM 95th %tile Q(veh)	0	-	3	-	-

Intersection	
Int Delay, s/veh	27.9

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Vol, veh/h	429	265	0	412	254	0
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	350	0	-	-	-	-
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	90	90	90	90	90	90
Heavy Vehicles, %	15	15	14	14	16	16
Mvmt Flow	477	294	0	458	282	0

Major/Minor	Minor2		Major1		Major2	
Conflicting Flow All	511	141	282	0	-	0
Stage 1	282	-	-	-	-	-
Stage 2	229	-	-	-	-	-
Critical Hdwy	7.1	7.2	4.38	-	-	-
Critical Hdwy Stg 1	6.1	-	-	-	-	-
Critical Hdwy Stg 2	6.1	-	-	-	-	-
Follow-up Hdwy	3.65	3.45	2.34	-	-	-
Pot Cap-1 Maneuver	~ 461	841	1195	-	-	-
Stage 1	703	-	-	-	-	-
Stage 2	750	-	-	-	-	-
Platoon blocked, %				-	-	-
Mov Cap-1 Maneuver	~ 461	841	1195	-	-	-
Mov Cap-2 Maneuver	~ 461	-	-	-	-	-
Stage 1	703	-	-	-	-	-
Stage 2	750	-	-	-	-	-

Approach	EB	NB	SB
HCM Control Delay, s	54.6		
HCM LOS	F		

Minor Lane/Major Mvmt	NBL	NBT	EBLn1	EBLn2	SBT	SBR
Capacity (veh/h)	1195	-	461	841	-	-
HCM Lane V/C Ratio	-	-	1.034	0.35	-	-
HCM Control Delay (s)	0	-	81.2	11.6	-	-
HCM Lane LOS	A	-	F	B	-	-
HCM 95th %tile Q(veh)	0	-	14	2	-	-

Notes

~: Volume exceeds capacity $: Delay exceeds 300s +: Computation Not Defined *: All major volume in platoon

Intersection	
Int Delay, s/veh	2.9

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Vol, veh/h	105	88	0	573	180	0
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	350	0	-	-	-	-
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	90	90	90	90	90	90
Heavy Vehicles, %	46	46	12	12	18	18
Mvmt Flow	117	98	0	637	200	0

Major/Minor	Minor2		Major1		Major2	
Conflicting Flow All	518	100	200	0	-	0
Stage 1	200	-	-	-	-	-
Stage 2	318	-	-	-	-	-
Critical Hdwy	7.72	7.82	4.34	-	-	-
Critical Hdwy Stg 1	6.72	-	-	-	-	-
Critical Hdwy Stg 2	6.72	-	-	-	-	-
Follow-up Hdwy	3.96	3.76	2.32	-	-	-
Pot Cap-1 Maneuver	393	811	1300	-	-	-
Stage 1	697	-	-	-	-	-
Stage 2	595	-	-	-	-	-
Platoon blocked, %				-	-	-
Mov Cap-1 Maneuver	393	811	1300	-	-	-
Mov Cap-2 Maneuver	393	-	-	-	-	-
Stage 1	697	-	-	-	-	-
Stage 2	595	-	-	-	-	-

Approach	EB	NB	SB
HCM Control Delay, s	14.4		
HCM LOS	B		

Minor Lane/Major Mvmt	NBL	NBT	EBLn1	EBLn2	SBT	SBR
Capacity (veh/h)	1300	-	393	811	-	-
HCM Lane V/C Ratio	-	-	0.297	0.121	-	-
HCM Control Delay (s)	0	-	18	10	-	-
HCM Lane LOS	A	-	C	B	-	-
HCM 95th %tile Q(veh)	0	-	1	0	-	-

Intersection	
Int Delay, s/veh	0

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Vol, veh/h	0	0	85	756	254	65
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	0	-	225	-	-	325
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	90	90	90	90	90	90
Heavy Vehicles, %	2	2	16	16	25	25
Mvmt Flow	0	0	94	840	282	72

Major/Minor	Minor2		Major1		Major2	
Conflicting Flow All	891	141	282	0	-	0
Stage 1	282	-	-	-	-	-
Stage 2	609	-	-	-	-	-
Critical Hdwy	6.84	6.94	4.42	-	-	-
Critical Hdwy Stg 1	5.84	-	-	-	-	-
Critical Hdwy Stg 2	5.84	-	-	-	-	-
Follow-up Hdwy	3.52	3.32	2.36	-	-	-
Pot Cap-1 Maneuver	282	881	1182	-	-	-
Stage 1	741	-	-	-	-	-
Stage 2	505	-	-	-	-	-
Platoon blocked, %				-	-	-
Mov Cap-1 Maneuver	260	881	1182	-	-	-
Mov Cap-2 Maneuver	260	-	-	-	-	-
Stage 1	741	-	-	-	-	-
Stage 2	465	-	-	-	-	-

Approach	EB	NB	SB
HCM Control Delay, s	0		
HCM LOS	A		

Minor Lane/Major Mvmt	NBL	NBT	EBLn1	SBT	SBR
Capacity (veh/h)	1182	-	-	-	-
HCM Lane V/C Ratio	0.08	-	-	-	-
HCM Control Delay (s)	8.3	-	0	-	-
HCM Lane LOS	A	-	A	-	-
HCM 95th %tile Q(veh)	0	-	-	-	-

Intersection	
Int Delay, s/veh	0

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Vol, veh/h	0	0	300	378	180	548
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	0	-	225	-	-	325
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	90	90	90	90	90	90
Heavy Vehicles, %	2	2	18	18	21	21
Mvmt Flow	0	0	333	420	200	609

Major/Minor	Minor2		Major1		Major2	
Conflicting Flow All	1077	100	200	0	-	0
Stage 1	200	-	-	-	-	-
Stage 2	877	-	-	-	-	-
Critical Hdwy	6.84	6.94	4.46	-	-	-
Critical Hdwy Stg 1	5.84	-	-	-	-	-
Critical Hdwy Stg 2	5.84	-	-	-	-	-
Follow-up Hdwy	3.52	3.32	2.38	-	-	-
Pot Cap-1 Maneuver	214	936	1260	-	-	-
Stage 1	814	-	-	-	-	-
Stage 2	367	-	-	-	-	-
Platoon blocked, %				-	-	-
Mov Cap-1 Maneuver	157	936	1260	-	-	-
Mov Cap-2 Maneuver	157	-	-	-	-	-
Stage 1	814	-	-	-	-	-
Stage 2	270	-	-	-	-	-

Approach	EB	NB	SB
HCM Control Delay, s	0		
HCM LOS	A		

Minor Lane/Major Mvmt	NBL	NBT	EBLn1	SBT	SBR
Capacity (veh/h)	1260	-	-	-	-
HCM Lane V/C Ratio	0.265	-	-	-	-
HCM Control Delay (s)	8.9	-	0	-	-
HCM Lane LOS	A	-	A	-	-
HCM 95th %tile Q(veh)	1	-	-	-	-

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Volume (veh/h)	434	69	178	654	1175	950
Number	3	18	1	6	2	12
Initial Q (Qb), veh	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00	1.00	1.00			1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1792	1900	1810	1810	1810	1810
Adj Flow Rate, veh/h	554	0	198	727	1306	1056
Adj No. of Lanes	2	1	1	2	2	1
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90
Percent Heavy Veh, %	6	0	5	5	5	5
Cap, veh/h	597	282	155	2591	2591	1159
Arrive On Green	0.17	0.00	0.75	0.75	1.00	1.00
Sat Flow, veh/h	3414	1615	146	3529	3529	1538
Grp Volume(v), veh/h	554	0	198	727	1306	1056
Grp Sat Flow(s),veh/h/ln	1707	1615	146	1719	1719	1538
Q Serve(g_s), s	25.5	0.0	120.1	10.5	0.0	0.0
Cycle Q Clear(g_c), s	25.5	0.0	120.1	10.5	0.0	0.0
Prop In Lane	1.00	1.00	1.00			1.00
Lane Grp Cap(c), veh/h	597	282	155	2591	2591	1159
V/C Ratio(X)	0.93	0.00	1.28	0.28	0.50	0.91
Avail Cap(c_a), veh/h	621	294	155	2591	2591	1159
HCM Platoon Ratio	1.00	1.00	1.00	1.00	2.00	2.00
Upstream Filter(I)	1.00	0.00	1.00	1.00	0.09	0.09
Uniform Delay (d), s/veh	64.8	0.0	37.1	6.1	0.0	0.0
Incr Delay (d2), s/veh	20.1	0.0	165.4	0.3	0.1	1.4
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	13.7	0.0	13.9	5.0	0.0	0.4
LnGrp Delay(d),s/veh	84.9	0.0	202.5	6.4	0.1	1.4
LnGrp LOS	F		F	A	A	A
Approach Vol, veh/h	554			925	2362	
Approach Delay, s/veh	84.9			48.4	0.7	
Approach LOS	F			D	A	

Timer	1	2	3	4	5	6	7	8
Assigned Phs		2				6		8
Phs Duration (G+Y+Rc), s		126.1				126.1		33.9
Change Period (Y+Rc), s		6.0				6.0		6.0
Max Green Setting (Gmax), s		119.0				119.0		29.0
Max Q Clear Time (g_c+I1), s		2.0				122.1		27.5
Green Ext Time (p_c), s		96.7				0.0		0.4

Intersection Summary	
HCM 2010 Ctrl Delay	24.3
HCM 2010 LOS	C

Notes

User approved volume balancing among the lanes for turning movement.

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Volume (veh/h)	597	133	185	908	943	618
Number	3	18	1	6	2	12
Initial Q (Qb), veh	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00	1.00	1.00			1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1827	1900	1827	1827	1827	1827
Adj Flow Rate, veh/h	801	0	206	1009	1048	687
Adj No. of Lanes	2	1	1	2	2	1
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90
Percent Heavy Veh, %	4	0	4	4	4	4
Cap, veh/h	872	405	242	2246	2246	1005
Arrive On Green	0.25	0.00	0.65	0.65	1.00	1.00
Sat Flow, veh/h	3480	1615	272	3563	3563	1553
Grp Volume(v), veh/h	801	0	206	1009	1048	687
Grp Sat Flow(s),veh/h/ln	1740	1615	272	1736	1736	1553
Q Serve(g_s), s	24.5	0.0	70.6	15.8	0.0	0.0
Cycle Q Clear(g_c), s	24.5	0.0	70.6	15.8	0.0	0.0
Prop In Lane	1.00	1.00	1.00			1.00
Lane Grp Cap(c), veh/h	872	405	242	2246	2246	1005
V/C Ratio(X)	0.92	0.00	0.85	0.45	0.47	0.68
Avail Cap(c_a), veh/h	924	429	242	2246	2246	1005
HCM Platoon Ratio	1.00	1.00	1.00	1.00	2.00	2.00
Upstream Filter(I)	1.00	0.00	1.00	1.00	0.20	0.20
Uniform Delay (d), s/veh	39.8	0.0	24.4	9.6	0.0	0.0
Incr Delay (d2), s/veh	13.5	0.0	29.4	0.7	0.1	0.8
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	13.4	0.0	8.2	7.8	0.0	0.2
LnGrp Delay(d),s/veh	53.3	0.0	53.8	10.2	0.1	0.8
LnGrp LOS	D		D	B	A	A
Approach Vol, veh/h	801			1215	1735	
Approach Delay, s/veh	53.3			17.6	0.4	
Approach LOS	D			B	A	

Timer	1	2	3	4	5	6	7	8
Assigned Phs		2				6		8
Phs Duration (G+Y+Rc), s		76.6				76.6		33.4
Change Period (Y+Rc), s		6.0				6.0		6.0
Max Green Setting (Gmax), s		69.0				69.0		29.0
Max Q Clear Time (g_c+I1), s		2.0				72.6		26.5
Green Ext Time (p_c), s		49.1				0.0		0.9

Intersection Summary	
HCM 2010 Ctrl Delay	17.3
HCM 2010 LOS	B

Notes

User approved volume balancing among the lanes for turning movement.

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Volume (veh/h)	572	333	113	975	1792	626
Number	3	18	1	6	2	12
Initial Q (Qb), veh	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00	1.00	1.00			1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1696	1900	1810	1810	1810	1810
Adj Flow Rate, veh/h	636	0	126	1083	1991	696
Adj No. of Lanes	2	1	1	2	2	1
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90
Percent Heavy Veh, %	12	0	5	5	5	5
Cap, veh/h	706	353	163	2545	2211	989
Arrive On Green	0.22	0.00	0.12	1.00	0.64	0.64
Sat Flow, veh/h	3231	1615	1723	3529	3529	1538
Grp Volume(v), veh/h	636	0	126	1083	1991	696
Grp Sat Flow(s),veh/h/ln	1616	1615	1723	1719	1719	1538
Q Serve(g_s), s	29.6	0.0	5.1	0.0	75.8	45.5
Cycle Q Clear(g_c), s	29.6	0.0	5.1	0.0	75.8	45.5
Prop In Lane	1.00	1.00	1.00			1.00
Lane Grp Cap(c), veh/h	706	353	163	2545	2211	989
V/C Ratio(X)	0.90	0.00	0.77	0.43	0.90	0.70
Avail Cap(c_a), veh/h	942	471	163	2545	2211	989
HCM Platoon Ratio	1.00	1.00	2.00	2.00	1.00	1.00
Upstream Filter(I)	1.00	0.00	0.80	0.80	1.00	1.00
Uniform Delay (d), s/veh	58.7	0.0	41.8	0.0	23.4	18.0
Incr Delay (d2), s/veh	9.4	0.0	16.5	0.4	6.4	4.2
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	14.2	0.0	5.8	0.1	37.7	20.3
LnGrp Delay(d),s/veh	68.1	0.0	58.3	0.4	29.8	22.2
LnGrp LOS	E		E	A	C	C
Approach Vol, veh/h	636			1209	2687	
Approach Delay, s/veh	68.1			6.5	27.8	
Approach LOS	E			A	C	

Timer	1	2	3	4	5	6	7	8
Assigned Phs	1	2				6		8
Phs Duration (G+Y+Rc), s	15.0	105.3				120.3		39.7
Change Period (Y+Rc), s	6.0	6.0				6.0		6.0
Max Green Setting (Gmax), s	9.0	88.0				103.0		45.0
Max Q Clear Time (g_c+I1), s	7.1	77.8				2.0		31.6
Green Ext Time (p_c), s	0.0	9.9				80.5		2.2

Intersection Summary	
HCM 2010 Ctrl Delay	27.8
HCM 2010 LOS	C

Notes

User approved volume balancing among the lanes for turning movement.

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Volume (veh/h)	801	273	74	1431	1288	535
Number	3	18	1	6	2	12
Initial Q (Qb), veh	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00	1.00	1.00			1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1743	1900	1827	1827	1810	1810
Adj Flow Rate, veh/h	890	0	82	1590	1431	594
Adj No. of Lanes	2	1	1	2	2	1
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90
Percent Heavy Veh, %	9	0	4	4	5	5
Cap, veh/h	994	483	235	2140	1638	733
Arrive On Green	0.30	0.00	0.11	0.82	0.48	0.48
Sat Flow, veh/h	3320	1615	1740	3563	3529	1538
Grp Volume(v), veh/h	890	0	82	1590	1431	594
Grp Sat Flow(s),veh/h/ln	1660	1615	1740	1736	1719	1538
Q Serve(g_s), s	27.5	0.0	2.2	22.6	40.0	35.3
Cycle Q Clear(g_c), s	27.5	0.0	2.2	22.6	40.0	35.3
Prop In Lane	1.00	1.00	1.00			1.00
Lane Grp Cap(c), veh/h	994	483	235	2140	1638	733
V/C Ratio(X)	0.90	0.00	0.35	0.74	0.87	0.81
Avail Cap(c_a), veh/h	1179	573	235	2140	1638	733
HCM Platoon Ratio	1.00	1.00	1.33	1.33	1.00	1.00
Upstream Filter(I)	1.00	0.00	0.69	0.69	1.00	1.00
Uniform Delay (d), s/veh	35.9	0.0	20.9	5.7	25.1	23.9
Incr Delay (d2), s/veh	8.2	0.0	0.6	1.7	6.8	9.5
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	13.7	0.0	1.2	10.9	20.4	16.8
LnGrp Delay(d),s/veh	44.1	0.0	21.5	7.4	31.9	33.4
LnGrp LOS	D		C	A	C	C
Approach Vol, veh/h	890			1672	2025	
Approach Delay, s/veh	44.1			8.1	32.4	
Approach LOS	D			A	C	

Timer	1	2	3	4	5	6	7	8
Assigned Phs	1	2				6		8
Phs Duration (G+Y+Rc), s	15.0	57.0				72.0		38.0
Change Period (Y+Rc), s	6.0	6.0				6.0		6.0
Max Green Setting (Gmax), s	9.0	45.0				60.0		38.0
Max Q Clear Time (g_c+I1), s	4.2	42.0				24.6		29.5
Green Ext Time (p_c), s	0.1	3.0				31.7		2.6

Intersection Summary	
HCM 2010 Ctrl Delay	25.8
HCM 2010 LOS	C

Notes

User approved volume balancing among the lanes for turning movement.

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	46	1074	331	36	887	314	135	12	117	15	14	84
Number	1	6	16	5	2	12	7	4	14	3	8	18
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1759	1759	1900	1827	1827	1827	1900	1792	1792	1863	1863	1900
Adj Flow Rate, veh/h	51	1193	368	40	986	349	150	13	130	17	16	93
Adj No. of Lanes	1	2	0	1	2	1	0	1	1	1	1	0
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Percent Heavy Veh, %	8	8	8	4	4	4	6	6	6	2	2	2
Cap, veh/h	273	1552	470	178	2129	953	291	21	346	161	54	314
Arrive On Green	0.61	0.61	0.61	0.61	0.61	0.61	0.23	0.23	0.23	0.23	0.23	0.23
Sat Flow, veh/h	386	2530	766	322	3471	1553	877	94	1524	1240	238	1381
Grp Volume(v), veh/h	51	781	780	40	986	349	163	0	130	17	0	109
Grp Sat Flow(s),veh/h/ln	386	1671	1624	322	1736	1553	971	0	1524	1240	0	1619
Q Serve(g_s), s	6.2	25.5	27.0	8.0	11.6	8.5	9.0	0.0	5.4	1.0	0.0	4.2
Cycle Q Clear(g_c), s	17.8	25.5	27.0	34.9	11.6	8.5	13.2	0.0	5.4	14.2	0.0	4.2
Prop In Lane	1.00		0.47	1.00		1.00	0.92		1.00	1.00		0.85
Lane Grp Cap(c), veh/h	273	1025	996	178	2129	953	313	0	346	161	0	368
V/C Ratio(X)	0.19	0.76	0.78	0.22	0.46	0.37	0.52	0.00	0.38	0.11	0.00	0.30
Avail Cap(c_a), veh/h	277	1042	1012	181	2163	968	377	0	424	224	0	451
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.00	1.00	1.00	0.00	1.00
Uniform Delay (d), s/veh	12.7	10.6	10.8	23.8	7.9	7.3	29.4	0.0	24.6	34.3	0.0	24.1
Incr Delay (d2), s/veh	0.3	3.3	4.0	0.6	0.2	0.2	1.3	0.0	0.7	0.3	0.0	0.4
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	0.7	12.4	13.0	0.7	5.5	3.6	3.3	0.0	2.3	0.4	0.0	1.9
LnGrp Delay(d),s/veh	13.0	13.9	14.9	24.5	8.0	7.5	30.7	0.0	25.3	34.6	0.0	24.6
LnGrp LOS	B	B	B	C	A	A	C		C	C		C
Approach Vol, veh/h		1612			1375			293			126	
Approach Delay, s/veh		14.3			8.4			28.3			25.9	
Approach LOS		B			A			C			C	

Timer	1	2	3	4	5	6	7	8
Assigned Phs		2		4		6		8
Phs Duration (G+Y+Rc), s		52.3		23.1		52.3		23.1
Change Period (Y+Rc), s		6.0		6.0		6.0		6.0
Max Green Setting (Gmax), s		47.0		21.0		47.0		21.0
Max Q Clear Time (g_c+I1), s		36.9		15.2		29.0		16.2
Green Ext Time (p_c), s		9.3		1.1		16.0		1.0

Intersection Summary	
HCM 2010 Ctrl Delay	13.6
HCM 2010 LOS	B

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	95	1061	294	54	838	353	190	14	132	25	14	48
Number	1	6	16	5	2	12	7	4	14	3	8	18
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1776	1776	1900	1827	1827	1827	1900	1827	1827	1863	1863	1900
Adj Flow Rate, veh/h	106	1179	327	60	931	392	211	16	147	28	16	53
Adj No. of Lanes	1	2	0	1	2	1	0	1	1	1	1	0
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Percent Heavy Veh, %	7	7	7	4	4	4	4	4	4	2	2	2
Cap, veh/h	271	1578	432	182	2091	935	350	20	382	153	94	310
Arrive On Green	0.60	0.60	0.60	0.60	0.60	0.60	0.25	0.25	0.25	0.25	0.25	0.25
Sat Flow, veh/h	394	2620	717	340	3471	1553	1068	81	1553	1218	380	1260
Grp Volume(v), veh/h	106	753	753	60	931	392	227	0	147	28	0	69
Grp Sat Flow(s),veh/h/ln	394	1687	1649	340	1736	1553	1149	0	1553	1218	0	1640
Q Serve(g_s), s	15.8	25.4	26.4	12.4	11.5	10.6	12.8	0.0	6.2	1.8	0.0	2.6
Cycle Q Clear(g_c), s	27.3	25.4	26.4	38.8	11.5	10.6	15.4	0.0	6.2	17.2	0.0	2.6
Prop In Lane	1.00		0.43	1.00		1.00	0.93		1.00	1.00		0.77
Lane Grp Cap(c), veh/h	271	1016	993	182	2091	935	370	0	382	153	0	403
V/C Ratio(X)	0.39	0.74	0.76	0.33	0.45	0.42	0.61	0.00	0.39	0.18	0.00	0.17
Avail Cap(c_a), veh/h	273	1025	1002	184	2108	943	380	0	393	161	0	415
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.00	1.00	1.00	0.00	1.00
Uniform Delay (d), s/veh	16.0	11.3	11.5	25.7	8.5	8.4	29.5	0.0	24.8	36.5	0.0	23.5
Incr Delay (d2), s/veh	0.9	2.9	3.4	1.0	0.1	0.3	2.8	0.0	0.6	0.6	0.0	0.2
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	1.8	12.5	12.8	1.2	5.5	4.5	5.0	0.0	2.7	0.6	0.0	1.2
LnGrp Delay(d),s/veh	16.9	14.2	14.9	26.7	8.7	8.7	32.3	0.0	25.5	37.0	0.0	23.7
LnGrp LOS	B	B	B	C	A	A	C		C	D		C
Approach Vol, veh/h		1612			1383			374			97	
Approach Delay, s/veh		14.7			9.5			29.6			27.5	
Approach LOS		B			A			C			C	

Timer	1	2	3	4	5	6	7	8
Assigned Phs		2		4		6		8
Phs Duration (G+Y+Rc), s		53.6		25.4		53.6		25.4
Change Period (Y+Rc), s		6.0		6.0		6.0		6.0
Max Green Setting (Gmax), s		48.0		20.0		48.0		20.0
Max Q Clear Time (g_c+I1), s		40.8		17.4		29.3		19.2
Green Ext Time (p_c), s		6.8		0.6		16.6		0.2

Intersection Summary	
HCM 2010 Ctrl Delay	14.6
HCM 2010 LOS	B

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	26	28	217	125	8	18	506	1407	249	38	1219	64
Number	3	8	18	7	4	14	1	6	16	5	2	12
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1827	1827	1827	1348	1348	1900	1792	1792	1900	1759	1759	1759
Adj Flow Rate, veh/h	29	31	241	139	9	20	562	1563	277	42	1354	71
Adj No. of Lanes	1	1	1	1	1	0	2	3	0	1	3	1
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Percent Heavy Veh, %	4	4	4	41	41	41	6	6	6	8	8	8
Cap, veh/h	342	385	327	242	79	174	655	2142	378	111	1828	569
Arrive On Green	0.21	0.21	0.21	0.21	0.21	0.21	0.20	0.51	0.51	0.07	0.38	0.38
Sat Flow, veh/h	1349	1827	1553	798	373	828	3312	4185	739	1675	4803	1495
Grp Volume(v), veh/h	29	31	241	139	0	29	562	1217	623	42	1354	71
Grp Sat Flow(s),veh/h/ln	1349	1827	1553	798	0	1201	1656	1631	1662	1675	1601	1495
Q Serve(g_s), s	1.5	1.2	12.4	14.4	0.0	1.7	14.0	24.8	25.0	2.0	20.7	2.6
Cycle Q Clear(g_c), s	3.2	1.2	12.4	15.6	0.0	1.7	14.0	24.8	25.0	2.0	20.7	2.6
Prop In Lane	1.00		1.00	1.00		0.69	1.00		0.44	1.00		1.00
Lane Grp Cap(c), veh/h	342	385	327	242	0	253	655	1669	850	111	1828	569
V/C Ratio(X)	0.08	0.08	0.74	0.58	0.00	0.11	0.86	0.73	0.73	0.38	0.74	0.12
Avail Cap(c_a), veh/h	359	407	346	251	0	268	777	1684	858	177	1860	579
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	1.00	1.00	0.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	28.5	27.0	31.4	33.3	0.0	27.2	33.0	16.2	16.3	38.1	22.8	17.2
Incr Delay (d2), s/veh	0.1	0.1	7.6	3.0	0.0	0.2	8.4	1.6	3.2	2.1	1.6	0.1
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	0.6	0.6	6.0	3.4	0.0	0.6	7.2	11.4	12.2	1.0	9.4	1.1
LnGrp Delay(d),s/veh	28.6	27.1	39.0	36.2	0.0	27.4	41.4	17.8	19.5	40.2	24.4	17.3
LnGrp LOS	C	C	D	D		C	D	B	B	D	C	B
Approach Vol, veh/h		301			168			2402			1467	
Approach Delay, s/veh		36.8			34.7			23.8			24.5	
Approach LOS		D			C			C			C	

Timer	1	2	3	4	5	6	7	8
Assigned Phs	1	2		4	5	6		8
Phs Duration (G+Y+Rc), s	22.8	38.4		23.9	11.7	49.6		23.9
Change Period (Y+Rc), s	6.0	6.0		6.0	6.0	6.0		6.0
Max Green Setting (Gmax), s	20.0	33.0		19.0	9.0	44.0		19.0
Max Q Clear Time (g_c+I1), s	16.0	22.7		17.6	4.0	27.0		14.4
Green Ext Time (p_c), s	0.9	9.7		0.3	0.0	15.7		1.0

Intersection Summary	
HCM 2010 Ctrl Delay	25.3
HCM 2010 LOS	C

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	81	20	421	285	35	26	247	1343	113	22	1200	51
Number	3	8	18	7	4	14	1	6	16	5	2	12
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1863	1863	1863	1429	1429	1900	1792	1792	1900	1776	1776	1776
Adj Flow Rate, veh/h	90	22	468	317	39	29	274	1492	126	24	1333	57
Adj No. of Lanes	1	1	1	1	1	0	2	3	0	1	3	1
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Percent Heavy Veh, %	2	2	2	33	33	33	6	6	6	7	7	7
Cap, veh/h	497	646	549	318	264	196	347	1838	155	77	1651	514
Arrive On Green	0.35	0.35	0.35	0.35	0.35	0.35	0.10	0.40	0.40	0.05	0.34	0.34
Sat Flow, veh/h	1328	1863	1583	692	762	567	3312	4598	388	1691	4848	1509
Grp Volume(v), veh/h	90	22	468	317	0	68	274	1058	560	24	1333	57
Grp Sat Flow(s),veh/h/ln	1328	1863	1583	692	0	1329	1656	1631	1724	1691	1616	1509
Q Serve(g_s), s	4.3	0.7	23.7	29.3	0.0	3.1	7.0	24.9	25.0	1.2	21.6	2.2
Cycle Q Clear(g_c), s	7.4	0.7	23.7	30.0	0.0	3.1	7.0	24.9	25.0	1.2	21.6	2.2
Prop In Lane	1.00		1.00	1.00		0.43	1.00		0.23	1.00		1.00
Lane Grp Cap(c), veh/h	497	646	549	318	0	460	347	1304	689	77	1651	514
V/C Ratio(X)	0.18	0.03	0.85	1.00	0.00	0.15	0.79	0.81	0.81	0.31	0.81	0.11
Avail Cap(c_a), veh/h	497	646	549	318	0	460	383	1304	689	176	1792	558
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	1.00	1.00	0.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	22.0	18.7	26.2	32.4	0.0	19.5	37.8	23.1	23.1	40.0	26.0	19.6
Incr Delay (d2), s/veh	0.2	0.0	12.3	49.8	0.0	0.1	9.7	4.0	7.3	2.3	2.7	0.1
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	1.6	0.4	12.2	11.9	0.0	1.1	3.7	11.9	13.2	0.6	10.0	0.9
LnGrp Delay(d),s/veh	22.2	18.7	38.6	82.2	0.0	19.6	47.5	27.1	30.4	42.3	28.6	19.7
LnGrp LOS	C	B	D	F		B	D	C	C	D	C	B
Approach Vol, veh/h		580			385			1892			1414	
Approach Delay, s/veh		35.3			71.2			31.0			28.5	
Approach LOS		D			E			C			C	

Timer	1	2	3	4	5	6	7	8
Assigned Phs	1	2		4	5	6		8
Phs Duration (G+Y+Rc), s	15.1	35.5		36.0	9.9	40.6		36.0
Change Period (Y+Rc), s	6.0	6.0		6.0	6.0	6.0		6.0
Max Green Setting (Gmax), s	10.0	32.0		30.0	9.0	33.0		30.0
Max Q Clear Time (g_c+I1), s	9.0	23.6		32.0	3.2	27.0		25.7
Green Ext Time (p_c), s	0.1	5.8		0.0	0.0	5.7		2.1

Intersection Summary	
HCM 2010 Ctrl Delay	34.4
HCM 2010 LOS	C

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	0	0	0	611	0	304	257	1858	0	0	1381	180
Number				3	8	18	5	2	12	1	6	16
Initial Q (Qb), veh				0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)				1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj				1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln				1681	0	1681	1759	1759	0	0	1792	1792
Adj Flow Rate, veh/h				679	0	338	286	2064	0	0	1534	200
Adj No. of Lanes				2	0	1	2	3	0	0	3	1
Peak Hour Factor				0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Percent Heavy Veh, %				13	0	13	8	8	0	0	6	6
Cap, veh/h				827	0	380	360	2860	0	0	2034	633
Arrive On Green				0.27	0.00	0.27	0.11	0.60	0.00	0.00	0.42	0.42
Sat Flow, veh/h				3107	0	1429	3250	4961	0	0	5055	1524
Grp Volume(v), veh/h				679	0	338	286	2064	0	0	1534	200
Grp Sat Flow(s),veh/h/ln				1553	0	1429	1625	1601	0	0	1631	1524
Q Serve(g_s), s				17.8	0.0	19.7	7.4	26.4	0.0	0.0	23.1	7.7
Cycle Q Clear(g_c), s				17.8	0.0	19.7	7.4	26.4	0.0	0.0	23.1	7.7
Prop In Lane				1.00		1.00	1.00		0.00	0.00		1.00
Lane Grp Cap(c), veh/h				827	0	380	360	2860	0	0	2034	633
V/C Ratio(X)				0.82	0.00	0.89	0.80	0.72	0.00	0.00	0.75	0.32
Avail Cap(c_a), veh/h				896	0	412	412	2936	0	0	2034	633
HCM Platoon Ratio				1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)				1.00	0.00	1.00	1.00	1.00	0.00	0.00	1.00	1.00
Uniform Delay (d), s/veh				29.9	0.0	30.6	37.6	12.4	0.0	0.0	21.6	17.0
Incr Delay (d2), s/veh				5.8	0.0	19.5	9.2	0.9	0.0	0.0	1.6	0.3
Initial Q Delay(d3),s/veh				0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln				8.3	0.0	9.9	3.8	11.7	0.0	0.0	10.7	3.3
LnGrp Delay(d),s/veh				35.7	0.0	50.1	46.8	13.3	0.0	0.0	23.2	17.3
LnGrp LOS				D		D	D	B			C	B
Approach Vol, veh/h					1017			2350			1734	
Approach Delay, s/veh					40.5			17.4			22.5	
Approach LOS					D			B			C	

Timer	1	2	3	4	5	6	7	8
Assigned Phs		2			5	6		8
Phs Duration (G+Y+Rc), s		57.6			15.6	42.0		29.1
Change Period (Y+Rc), s		6.0			6.0	6.0		6.0
Max Green Setting (Gmax), s		53.0			11.0	36.0		25.0
Max Q Clear Time (g_c+I1), s		28.4			9.4	25.1		21.7
Green Ext Time (p_c), s		23.2			0.2	10.6		1.4

Intersection Summary	
HCM 2010 Ctrl Delay	23.7
HCM 2010 LOS	C

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	0	0	0	779	0	241	626	1462	0	0	1642	264
Number				3	8	18	5	2	12	1	6	16
Initial Q (Qb), veh				0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)				1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj				1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln				1712	0	1712	1792	1792	0	0	1792	1792
Adj Flow Rate, veh/h				866	0	268	696	1624	0	0	1824	293
Adj No. of Lanes				2	0	1	2	3	0	0	3	1
Peak Hour Factor				0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Percent Heavy Veh, %				11	0	11	6	6	0	0	6	6
Cap, veh/h				843	0	388	690	3099	0	0	1835	571
Arrive On Green				0.27	0.00	0.27	0.21	0.63	0.00	0.00	0.38	0.38
Sat Flow, veh/h				3163	0	1455	3312	5055	0	0	5055	1524
Grp Volume(v), veh/h				866	0	268	696	1624	0	0	1824	293
Grp Sat Flow(s),veh/h/ln				1581	0	1455	1656	1631	0	0	1631	1524
Q Serve(g_s), s				32.0	0.0	19.9	25.0	21.9	0.0	0.0	44.6	17.9
Cycle Q Clear(g_c), s				32.0	0.0	19.9	25.0	21.9	0.0	0.0	44.6	17.9
Prop In Lane				1.00		1.00	1.00		0.00	0.00		1.00
Lane Grp Cap(c), veh/h				843	0	388	690	3099	0	0	1835	571
V/C Ratio(X)				1.03	0.00	0.69	1.01	0.52	0.00	0.00	0.99	0.51
Avail Cap(c_a), veh/h				843	0	388	690	3099	0	0	1835	571
HCM Platoon Ratio				1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)				1.00	0.00	1.00	1.00	1.00	0.00	0.00	1.00	1.00
Uniform Delay (d), s/veh				44.0	0.0	39.6	47.5	12.1	0.0	0.0	37.4	29.0
Incr Delay (d2), s/veh				38.0	0.0	5.1	36.4	0.2	0.0	0.0	19.5	0.8
Initial Q Delay(d3),s/veh				0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln				18.4	0.0	8.5	14.9	9.8	0.0	0.0	23.2	7.6
LnGrp Delay(d),s/veh				82.0	0.0	44.7	84.0	12.2	0.0	0.0	56.9	29.8
LnGrp LOS				F		D	F	B			E	C
Approach Vol, veh/h					1134			2320			2117	
Approach Delay, s/veh					73.2			33.8			53.2	
Approach LOS					E			C			D	

Timer	1	2	3	4	5	6	7	8
Assigned Phs		2			5	6		8
Phs Duration (G+Y+Rc), s		82.0			31.0	51.0		38.0
Change Period (Y+Rc), s		6.0			6.0	6.0		6.0
Max Green Setting (Gmax), s		76.0			25.0	45.0		32.0
Max Q Clear Time (g_c+I1), s		23.9			27.0	46.6		34.0
Green Ext Time (p_c), s		45.8			0.0	0.0		0.0

Intersection Summary	
HCM 2010 Ctrl Delay	49.2
HCM 2010 LOS	D

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	12	101	344	108	61	15	257	362	206	5	184	36
Number	7	4	14	3	8	18	5	2	12	1	6	16
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1900	1827	1827	1863	1863	1900	1792	1792	1792	1900	1810	1900
Adj Flow Rate, veh/h	13	112	382	120	68	17	286	402	229	6	204	40
Adj No. of Lanes	0	1	1	1	1	0	1	1	1	0	2	0
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Percent Heavy Veh, %	4	4	4	2	2	2	6	6	6	5	5	5
Cap, veh/h	68	411	618	439	602	150	506	775	659	52	553	105
Arrive On Green	0.24	0.24	0.24	0.10	0.42	0.42	0.16	0.43	0.43	0.20	0.20	0.20
Sat Flow, veh/h	76	1719	1553	1774	1439	360	1707	1792	1524	24	2778	528
Grp Volume(v), veh/h	125	0	382	120	0	85	286	402	229	132	0	118
Grp Sat Flow(s),veh/h/ln	1795	0	1553	1774	0	1799	1707	1792	1524	1777	0	1553
Q Serve(g_s), s	0.0	0.0	15.8	3.7	0.0	2.3	10.0	13.2	8.1	0.0	0.0	5.3
Cycle Q Clear(g_c), s	4.5	0.0	15.8	3.7	0.0	2.3	10.0	13.2	8.1	5.1	0.0	5.3
Prop In Lane	0.10		1.00	1.00		0.20	1.00		1.00	0.05		0.34
Lane Grp Cap(c), veh/h	479	0	618	439	0	752	506	775	659	401	0	309
V/C Ratio(X)	0.26	0.00	0.62	0.27	0.00	0.11	0.57	0.52	0.35	0.33	0.00	0.38
Avail Cap(c_a), veh/h	583	0	710	541	0	963	915	1450	1233	634	0	522
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	0.00	1.00	1.00	0.00	1.00	1.00	1.00	1.00	1.00	0.00	1.00
Uniform Delay (d), s/veh	25.0	0.0	19.3	17.5	0.0	14.3	18.8	16.7	15.2	27.8	0.0	27.9
Incr Delay (d2), s/veh	0.3	0.0	1.3	0.3	0.0	0.1	1.0	0.5	0.3	0.5	0.0	0.8
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	2.3	0.0	6.9	1.8	0.0	1.2	4.7	6.6	3.4	2.6	0.0	2.3
LnGrp Delay(d),s/veh	25.3	0.0	20.6	17.8	0.0	14.3	19.8	17.2	15.5	28.3	0.0	28.6
LnGrp LOS	C		C	B		B	B	B	B	C		C
Approach Vol, veh/h		507			205			917			250	
Approach Delay, s/veh		21.8			16.4			17.6			28.4	
Approach LOS		C			B			B			C	

Timer	1	2	3	4	5	6	7	8
Assigned Phs		2	3	4	5	6		8
Phs Duration (G+Y+Rc), s		40.7	14.4	25.2	18.7	22.0		39.6
Change Period (Y+Rc), s		6.0	6.0	6.0	6.0	6.0		6.0
Max Green Setting (Gmax), s		65.0	13.0	24.0	32.0	27.0		43.0
Max Q Clear Time (g_c+I1), s		15.2	5.7	17.8	12.0	7.3		4.3
Green Ext Time (p_c), s		5.3	0.1	1.4	0.8	4.6		2.7

Intersection Summary	
HCM 2010 Ctrl Delay	20.0
HCM 2010 LOS	C

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	16	69	397	184	98	7	265	269	164	4	329	33
Number	7	4	14	3	8	18	5	2	12	1	6	16
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1900	1845	1845	1863	1863	1900	1810	1810	1810	1900	1827	1900
Adj Flow Rate, veh/h	18	77	441	204	109	8	294	299	182	4	366	37
Adj No. of Lanes	0	1	1	1	1	0	1	1	1	0	2	0
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Percent Heavy Veh, %	3	3	3	2	2	2	5	5	5	4	4	4
Cap, veh/h	97	353	606	450	708	52	455	790	672	48	623	62
Arrive On Green	0.23	0.23	0.23	0.11	0.41	0.41	0.16	0.44	0.44	0.20	0.20	0.20
Sat Flow, veh/h	192	1564	1568	1774	1715	126	1723	1810	1538	9	3106	310
Grp Volume(v), veh/h	95	0	441	204	0	117	294	299	182	215	0	192
Grp Sat Flow(s),veh/h/ln	1755	0	1568	1774	0	1841	1723	1810	1538	1818	0	1608
Q Serve(g_s), s	0.0	0.0	18.0	6.6	0.0	3.2	10.1	8.9	6.0	0.0	0.0	8.6
Cycle Q Clear(g_c), s	3.4	0.0	18.0	6.6	0.0	3.2	10.1	8.9	6.0	8.5	0.0	8.6
Prop In Lane	0.19		1.00	1.00		0.07	1.00		1.00	0.02		0.19
Lane Grp Cap(c), veh/h	450	0	606	450	0	759	455	790	672	411	0	323
V/C Ratio(X)	0.21	0.00	0.73	0.45	0.00	0.15	0.65	0.38	0.27	0.52	0.00	0.59
Avail Cap(c_a), veh/h	450	0	606	630	0	946	827	1521	1292	748	0	625
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	0.00	1.00	1.00	0.00	1.00	1.00	1.00	1.00	1.00	0.00	1.00
Uniform Delay (d), s/veh	25.2	0.0	20.9	18.5	0.0	14.7	19.1	15.1	14.3	28.9	0.0	28.9
Incr Delay (d2), s/veh	0.2	0.0	4.4	0.7	0.0	0.1	1.5	0.3	0.2	1.0	0.0	1.7
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	1.7	0.0	8.9	3.3	0.0	1.6	4.8	4.5	2.6	4.4	0.0	4.0
LnGrp Delay(d),s/veh	25.4	0.0	25.2	19.3	0.0	14.8	20.6	15.4	14.6	29.9	0.0	30.7
LnGrp LOS	C		C	B		B	C	B	B	C		C
Approach Vol, veh/h		536			321			775			407	
Approach Delay, s/veh		25.3			17.6			17.2			30.3	
Approach LOS		C			B			B			C	

Timer	1	2	3	4	5	6	7	8
Assigned Phs		2	3	4	5	6		8
Phs Duration (G+Y+Rc), s		40.8	14.9	24.0	18.8	22.0		38.9
Change Period (Y+Rc), s		6.0	6.0	6.0	6.0	6.0		6.0
Max Green Setting (Gmax), s		67.0	17.0	18.0	30.0	31.0		41.0
Max Q Clear Time (g_c+I1), s		10.9	8.6	20.0	12.1	10.6		5.2
Green Ext Time (p_c), s		5.4	0.3	0.0	0.8	4.7		2.9

Intersection Summary	
HCM 2010 Ctrl Delay	22.0
HCM 2010 LOS	C

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	137	886	0	0	482	121	308	0	71	0	0	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	6.0	6.0			6.0		6.0		6.0			
Lane Util. Factor	1.00	0.95			0.95		0.97		1.00			
Frt	1.00	1.00			0.97		1.00		0.85			
Flt Protected	0.95	1.00			1.00		0.95		1.00			
Satd. Flow (prot)	1671	3343			3303		2918		1346			
Flt Permitted	0.31	1.00			1.00		0.95		1.00			
Satd. Flow (perm)	553	3343			3303		2918		1346			
Peak-hour factor, PHF	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Adj. Flow (vph)	152	984	0	0	536	134	342	0	79	0	0	0
RTOR Reduction (vph)	0	0	0	0	19	0	0	0	63	0	0	0
Lane Group Flow (vph)	152	984	0	0	651	0	342	0	16	0	0	0
Heavy Vehicles (%)	8%	8%	8%	6%	6%	6%	20%	20%	20%	2%	2%	2%
Turn Type	custom	NA			NA		Prot		Prot			
Protected Phases	5 8	2 5 8			6		7		7			
Permitted Phases	2						7		7			
Actuated Green, G (s)	72.9	72.9			44.9		23.8		23.8			
Effective Green, g (s)	72.9	72.9			44.9		23.8		23.8			
Actuated g/C Ratio	0.62	0.62			0.38		0.20		0.20			
Clearance Time (s)					6.0		6.0		6.0			
Vehicle Extension (s)					3.0		3.0		3.0			
Lane Grp Cap (vph)	636	2070			1260		590		272			
v/s Ratio Prot	0.06	c0.29			c0.20		c0.12		0.01			
v/s Ratio Perm	0.08											
v/c Ratio	0.24	0.48			0.52		0.58		0.06			
Uniform Delay, d1	9.8	12.1			28.0		42.4		37.9			
Progression Factor	1.32	0.85			1.00		1.00		1.00			
Incremental Delay, d2	0.2	0.1			0.4		1.4		0.1			
Delay (s)	13.1	10.4			28.4		43.8		38.0			
Level of Service	B	B			C		D		D			
Approach Delay (s)		10.7			28.4			42.7			0.0	
Approach LOS		B			C			D			A	

Intersection Summary			
HCM 2000 Control Delay	22.1	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.55		
Actuated Cycle Length (s)	117.7	Sum of lost time (s)	24.0
Intersection Capacity Utilization	81.4%	ICU Level of Service	D
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	265	630	0	0	773	292	342	0	114	0	0	0
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	6.0	6.0			6.0		6.0		6.0			
Lane Util. Factor	1.00	0.95			0.95		0.97		1.00			
Frt	1.00	1.00			0.96		1.00		0.85			
Flt Protected	0.95	1.00			1.00		0.95		1.00			
Satd. Flow (prot)	1703	3406			3297		3072		1417			
Flt Permitted	0.12	1.00			1.00		0.95		1.00			
Satd. Flow (perm)	211	3406			3297		3072		1417			
Peak-hour factor, PHF	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Adj. Flow (vph)	294	700	0	0	859	324	380	0	127	0	0	0
RTOR Reduction (vph)	0	0	0	0	33	0	0	0	107	0	0	0
Lane Group Flow (vph)	294	700	0	0	1150	0	380	0	20	0	0	0
Heavy Vehicles (%)	6%	6%	6%	5%	5%	5%	14%	14%	14%	2%	2%	2%
Turn Type	custom	NA			NA		Prot		Prot			
Protected Phases	5 8	2 5 8			6		7		7			
Permitted Phases	2						7		7			
Actuated Green, G (s)	72.7	72.7			50.1		18.2		18.2			
Effective Green, g (s)	72.7	72.7			50.1		18.2		18.2			
Actuated g/C Ratio	0.62	0.62			0.42		0.15		0.15			
Clearance Time (s)					6.0		6.0		6.0			
Vehicle Extension (s)					3.0		3.0		3.0			
Lane Grp Cap (vph)	531	2096			1398		473		218			
v/s Ratio Prot	c0.15	0.21			c0.35		c0.12		0.01			
v/s Ratio Perm	0.19											
v/c Ratio	0.55	0.33			0.82		0.80		0.09			
Uniform Delay, d1	20.6	11.0			30.1		48.2		42.8			
Progression Factor	2.05	0.75			1.00		1.00		1.00			
Incremental Delay, d2	0.9	0.1			4.0		9.5		0.2			
Delay (s)	43.2	8.3			34.1		57.8		43.0			
Level of Service	D	A			C		E		D			
Approach Delay (s)		18.6			34.1			54.1			0.0	
Approach LOS		B			C			D			A	

Intersection Summary			
HCM 2000 Control Delay	32.1	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.78		
Actuated Cycle Length (s)	118.1	Sum of lost time (s)	24.0
Intersection Capacity Utilization	70.1%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	681	646	73	717	0	0	0	0	342	0	234
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		6.0	6.0	6.0	6.0					6.0		6.0
Lane Util. Factor		0.95	1.00	1.00	0.95					1.00		1.00
Frt		1.00	0.85	1.00	1.00					1.00		0.85
Flt Protected		1.00	1.00	0.95	1.00					0.95		1.00
Satd. Flow (prot)		3282	1468	1671	3343					1626		1455
Flt Permitted		1.00	1.00	0.21	1.00					0.95		1.00
Satd. Flow (perm)		3282	1468	376	3343					1626		1455
Peak-hour factor, PHF	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Adj. Flow (vph)	0	757	718	81	797	0	0	0	0	380	0	260
RTOR Reduction (vph)	0	0	127	0	0	0	0	0	0	0	0	75
Lane Group Flow (vph)	0	757	591	81	797	0	0	0	0	380	0	185
Heavy Vehicles (%)	10%	10%	10%	8%	8%	8%	2%	2%	2%	11%	11%	11%
Turn Type		NA	custom	custom	NA					custom		custom
Protected Phases		2		1	1 6					7 8		7 8
Permitted Phases			2 7 8	6						7 8		7 8
Actuated Green, G (s)		41.9	93.7	56.9	56.9					45.8		45.8
Effective Green, g (s)		41.9	93.7	56.9	56.9					45.8		45.8
Actuated g/C Ratio		0.36	0.80	0.48	0.48					0.39		0.39
Clearance Time (s)		6.0		6.0								
Vehicle Extension (s)		3.0		3.0								
Lane Grp Cap (vph)		1168	1168	313	1616					632		566
v/s Ratio Prot		c0.23		0.03	c0.24					c0.23		0.13
v/s Ratio Perm			0.40	0.10								
v/c Ratio		0.65	0.51	0.26	0.49					0.60		0.33
Uniform Delay, d1		31.7	4.1	18.2	20.6					28.7		25.2
Progression Factor		1.00	1.00	0.53	1.09					1.00		1.00
Incremental Delay, d2		1.3	0.3	0.4	0.2					1.6		0.3
Delay (s)		33.0	4.4	10.0	22.7					30.3		25.5
Level of Service		C	A	A	C					C		C
Approach Delay (s)		19.1			21.6			0.0			28.3	
Approach LOS		B			C			A			C	

Intersection Summary			
HCM 2000 Control Delay	21.8	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.65		
Actuated Cycle Length (s)	117.7	Sum of lost time (s)	24.0
Intersection Capacity Utilization	81.4%	ICU Level of Service	D
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (vph)	0	713	425	109	1006	0	0	0	0	182	0	214
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)		6.0	6.0	6.0	6.0					6.0		6.0
Lane Util. Factor		0.95	1.00	1.00	0.95					1.00		1.00
Frt		1.00	0.85	1.00	1.00					1.00		0.85
Flt Protected		1.00	1.00	0.95	1.00					0.95		1.00
Satd. Flow (prot)		3343	1495	1703	3406					1583		1417
Flt Permitted		1.00	1.00	0.18	1.00					0.95		1.00
Satd. Flow (perm)		3343	1495	318	3406					1583		1417
Peak-hour factor, PHF	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Adj. Flow (vph)	0	792	472	121	1118	0	0	0	0	202	0	238
RTOR Reduction (vph)	0	0	124	0	0	0	0	0	0	0	0	90
Lane Group Flow (vph)	0	792	348	121	1118	0	0	0	0	202	0	148
Heavy Vehicles (%)	8%	8%	8%	6%	6%	6%	2%	2%	2%	14%	14%	14%
Turn Type		NA	custom	custom	NA					custom		custom
Protected Phases		2		1	1 6					7 8		7 8
Permitted Phases			2 7 8	6						7 8		7 8
Actuated Green, G (s)		40.9	87.1	65.9	65.9					40.2		40.2
Effective Green, g (s)		40.9	87.1	65.9	65.9					40.2		40.2
Actuated g/C Ratio		0.35	0.74	0.56	0.56					0.34		0.34
Clearance Time (s)		6.0		6.0								
Vehicle Extension (s)		3.0		3.0								
Lane Grp Cap (vph)		1157	1102	400	1900					538		482
v/s Ratio Prot		c0.24		0.05	c0.33					c0.13		0.10
v/s Ratio Perm			0.23	0.12								
v/c Ratio		0.68	0.32	0.30	0.59					0.38		0.31
Uniform Delay, d1		33.1	5.3	15.3	17.2					29.5		28.7
Progression Factor		1.00	1.00	1.16	0.96					1.00		1.00
Incremental Delay, d2		1.7	0.2	0.2	0.3					0.4		0.4
Delay (s)		34.8	5.5	18.0	16.8					29.9		29.1
Level of Service		C	A	B	B					C		C
Approach Delay (s)		23.8			16.9			0.0			29.4	
Approach LOS		C			B			A			C	

Intersection Summary			
HCM 2000 Control Delay	21.7	HCM 2000 Level of Service	C
HCM 2000 Volume to Capacity ratio	0.60		
Actuated Cycle Length (s)	118.1	Sum of lost time (s)	24.0
Intersection Capacity Utilization	70.1%	ICU Level of Service	C
Analysis Period (min)	15		

c Critical Lane Group

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	201	262	332	178	135	63	569	1277	287	39	613	110
Number	3	8	18	7	4	14	1	6	16	5	2	12
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1776	1776	1776	1792	1792	1900	1810	1810	1810	1810	1810	1810
Adj Flow Rate, veh/h	223	291	369	198	150	70	632	1419	319	43	681	122
Adj No. of Lanes	1	2	1	1	2	0	1	2	1	1	2	1
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Percent Heavy Veh, %	7	7	7	6	6	6	5	5	5	5	5	5
Cap, veh/h	285	701	790	272	741	330	619	2009	899	115	765	342
Arrive On Green	0.21	0.21	0.21	0.07	0.32	0.32	0.32	0.58	0.58	0.22	0.22	0.22
Sat Flow, veh/h	1102	3374	1509	1707	2293	1022	1723	3438	1538	269	3438	1538
Grp Volume(v), veh/h	223	291	369	198	110	110	632	1419	319	43	681	122
Grp Sat Flow(s),veh/h/ln	1102	1687	1509	1707	1703	1612	1723	1719	1538	269	1719	1538
Q Serve(g_s), s	26.1	9.7	20.0	9.0	6.0	6.5	41.0	38.0	14.1	19.2	24.9	8.7
Cycle Q Clear(g_c), s	26.1	9.7	20.0	9.0	6.0	6.5	41.0	38.0	14.1	19.2	24.9	8.7
Prop In Lane	1.00		1.00	1.00		0.63	1.00		1.00	1.00		1.00
Lane Grp Cap(c), veh/h	285	701	790	272	551	521	619	2009	899	115	765	342
V/C Ratio(X)	0.78	0.41	0.47	0.73	0.20	0.21	1.02	0.71	0.35	0.37	0.89	0.36
Avail Cap(c_a), veh/h	285	701	790	272	551	521	619	2012	900	115	768	343
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	51.1	44.6	19.5	40.8	31.8	31.9	34.8	19.1	14.2	46.7	49.0	42.7
Incr Delay (d2), s/veh	13.3	0.4	0.4	9.3	0.2	0.2	41.4	1.2	0.2	2.0	12.6	0.6
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	9.0	4.6	8.4	3.3	2.9	2.9	29.1	18.3	6.0	1.5	13.2	3.8
LnGrp Delay(d),s/veh	64.4	45.0	19.9	50.2	32.0	32.1	76.3	20.3	14.4	48.7	61.5	43.3
LnGrp LOS	E	D	B	D	C	C	F	C	B	D	E	D
Approach Vol, veh/h		883			418			2370			846	
Approach Delay, s/veh		39.4			40.6			34.4			58.2	
Approach LOS		D			D			C			E	

Timer	1	2	3	4	5	6	7	8
Assigned Phs	1	2		4		6	7	8
Phs Duration (G+Y+Rc), s	47.0	34.9		48.0		81.9	15.0	33.0
Change Period (Y+Rc), s	6.0	6.0		6.0		6.0	6.0	6.0
Max Green Setting (Gmax), s	41.0	29.0		42.0		76.0	9.0	27.0
Max Q Clear Time (g_c+I1), s	43.0	26.9		8.5		40.0	11.0	28.1
Green Ext Time (p_c), s	0.0	1.9		6.2		25.8	0.0	0.0

Intersection Summary	
HCM 2010 Ctrl Delay	40.4
HCM 2010 LOS	D

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	95	153	548	259	316	56	354	843	166	27	1168	145
Number	3	8	18	7	4	14	1	6	16	5	2	12
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1792	1792	1792	1810	1810	1900	1827	1827	1827	1827	1827	1827
Adj Flow Rate, veh/h	106	170	609	288	351	62	393	937	184	30	1298	161
Adj No. of Lanes	1	2	1	1	2	0	1	2	1	1	2	1
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Percent Heavy Veh, %	6	6	6	5	5	5	4	4	4	4	4	4
Cap, veh/h	173	426	492	257	755	132	417	2250	1007	254	1402	627
Arrive On Green	0.13	0.13	0.13	0.09	0.26	0.26	0.20	0.65	0.65	0.40	0.40	0.40
Sat Flow, veh/h	932	3406	1524	1723	2926	512	1740	3471	1553	491	3471	1553
Grp Volume(v), veh/h	106	170	609	288	205	208	393	937	184	30	1298	161
Grp Sat Flow(s),veh/h/ln	932	1703	1524	1723	1719	1719	1740	1736	1553	491	1736	1553
Q Serve(g_s), s	14.4	5.9	16.0	11.0	12.8	13.1	23.0	16.6	6.0	5.0	45.6	8.8
Cycle Q Clear(g_c), s	14.4	5.9	16.0	11.0	12.8	13.1	23.0	16.6	6.0	5.0	45.6	8.8
Prop In Lane	1.00		1.00	1.00		0.30	1.00		1.00	1.00		1.00
Lane Grp Cap(c), veh/h	173	426	492	257	443	443	417	2250	1007	254	1402	627
V/C Ratio(X)	0.61	0.40	1.24	1.12	0.46	0.47	0.94	0.42	0.18	0.12	0.93	0.26
Avail Cap(c_a), veh/h	173	426	492	257	443	443	440	2306	1032	256	1411	631
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	55.3	51.6	43.3	49.4	40.0	40.1	39.0	10.8	9.0	24.2	36.3	25.4
Incr Delay (d2), s/veh	6.3	0.6	124.0	91.8	0.8	0.8	28.1	0.1	0.1	0.2	10.6	0.2
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	4.0	2.8	34.2	6.6	6.2	6.3	16.9	8.0	2.6	0.7	23.9	3.8
LnGrp Delay(d),s/veh	61.5	52.2	167.3	141.2	40.7	40.9	67.1	11.0	9.1	24.4	47.0	25.6
LnGrp LOS	E	D	F	F	D	D	E	B	A	C	D	C
Approach Vol, veh/h		885			701			1514			1489	
Approach Delay, s/veh		132.5			82.0			25.3			44.2	
Approach LOS		F			F			C			D	

Timer	1	2	3	4	5	6	7	8
Assigned Phs	1	2		4		6	7	8
Phs Duration (G+Y+Rc), s	31.3	57.7		39.0		89.0	17.0	22.0
Change Period (Y+Rc), s	6.0	6.0		6.0		6.0	6.0	6.0
Max Green Setting (Gmax), s	27.0	52.0		33.0		85.0	11.0	16.0
Max Q Clear Time (g_c+I1), s	25.0	47.6		15.1		18.6	13.0	18.0
Green Ext Time (p_c), s	0.3	4.1		6.4		37.4	0.0	0.0

Intersection Summary	
HCM 2010 Ctrl Delay	60.8
HCM 2010 LOS	E

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (veh/h)	34	227	217	227	569	13
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90
Hourly flow rate (vph)	38	252	241	252	632	14
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type		None	None			
Median storage veh)						
Upstream signal (ft)			1199			
pX, platoon unblocked						
vC, conflicting volume	493				569	247
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	493				569	247
tC, single (s)	4.2				7.0	7.1
tC, 2 stage (s)						
tF (s)	2.3				3.6	3.4
p0 queue free %	96				0	98
cM capacity (veh/h)	1039				422	736

Direction, Lane #	EB 1	EB 2	EB 3	WB 1	WB 2	SB 1	SB 2
Volume Total	38	126	126	161	333	421	225
Volume Left	38	0	0	0	0	421	211
Volume Right	0	0	0	0	252	0	14
cSH	1039	1700	1700	1700	1700	422	434
Volume to Capacity	0.04	0.07	0.07	0.09	0.20	1.00	0.52
Queue Length 95th (ft)	3	0	0	0	0	313	73
Control Delay (s)	8.6	0.0	0.0	0.0	0.0	74.9	21.9
Lane LOS	A					F	C
Approach Delay (s)	1.1			0.0		56.4	
Approach LOS						F	

Intersection Summary			
Average Delay	25.7		
Intersection Capacity Utilization	43.3%	ICU Level of Service	A
Analysis Period (min)	15		

Movement	EBL	EBT	WBT	WBR	SBL	SBR
Lane Configurations						
Volume (veh/h)	39	203	527	189	253	12
Sign Control		Free	Free		Stop	
Grade		0%	0%		0%	
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90
Hourly flow rate (vph)	43	226	586	210	281	13
Pedestrians						
Lane Width (ft)						
Walking Speed (ft/s)						
Percent Blockage						
Right turn flare (veh)						
Median type		None	None			
Median storage veh)						
Upstream signal (ft)			1199			
pX, platoon unblocked	0.93				0.93	0.93
vC, conflicting volume	796				890	398
vC1, stage 1 conf vol						
vC2, stage 2 conf vol						
vCu, unblocked vol	629				731	201
tC, single (s)	4.1				7.0	7.1
tC, 2 stage (s)						
tF (s)	2.2				3.6	3.4
p0 queue free %	95				8	98
cM capacity (veh/h)	882				305	732

Direction, Lane #	EB 1	EB 2	EB 3	WB 1	WB 2	SB 1	SB 2
Volume Total	43	113	113	390	405	187	107
Volume Left	43	0	0	0	0	187	94
Volume Right	0	0	0	0	210	0	13
cSH	882	1700	1700	1700	1700	305	329
Volume to Capacity	0.05	0.07	0.07	0.23	0.24	0.62	0.33
Queue Length 95th (ft)	4	0	0	0	0	95	35
Control Delay (s)	9.3	0.0	0.0	0.0	0.0	34.0	21.2
Lane LOS	A					D	C
Approach Delay (s)	1.5			0.0		29.3	
Approach LOS						D	

Intersection Summary			
Average Delay	6.7		
Intersection Capacity Utilization	41.5%	ICU Level of Service	A
Analysis Period (min)	15		

Intersection	
Int Delay, s/veh	7.4

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR
Vol, veh/h	0	0	230	0	0	261	0	164	582
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0
Sign Control	Stop	Stop	Stop	Stop	Stop	Stop	Free	Free	Free
RT Channelized	-	-	Yield	-	-	Yield	-	-	Free
Storage Length	-	-	0	-	-	0	125	-	0
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-
Peak Hour Factor	90	90	90	90	90	90	90	90	90
Heavy Vehicles, %	6	6	6	8	8	8	16	16	16
Mvmt Flow	0	0	256	0	0	290	0	182	647

Major/Minor	Minor2			Minor1			Major1		
Conflicting Flow All	105	196	14	196	196	91	14	0	-
Stage 1	14	14	-	182	182	-	-	-	-
Stage 2	91	182	-	14	14	-	-	-	-
Critical Hdwy	7.39	6.59	6.29	7.42	6.62	7.02	4.26	-	-
Critical Hdwy Stg 1	6.19	5.59	-	6.62	5.62	-	-	-	-
Critical Hdwy Stg 2	6.59	5.59	-	6.22	5.62	-	-	-	-
Follow-up Hdwy	3.557	4.057	3.357	3.576	4.076	3.376	2.344	-	-
Pot Cap-1 Maneuver	859	691	1053	740	687	932	1517	-	0
Stage 1	995	875	-	787	736	-	-	-	0
Stage 2	896	740	-	990	871	-	-	-	0
Platoon blocked, %								-	
Mov Cap-1 Maneuver	592	691	1053	560	687	932	1517	-	-
Mov Cap-2 Maneuver	592	691	-	560	687	-	-	-	-
Stage 1	995	875	-	787	736	-	-	-	-
Stage 2	617	740	-	750	871	-	-	-	-

Approach	EB	WB	NB
HCM Control Delay, s	9.5	10.6	
HCM LOS	A	B	

Minor Lane/Major Mvmt	NBL	NBT	EBLn1	WBLn1	SBL	SBT
Capacity (veh/h)	1517	-	1053	932	1263	-
HCM Lane V/C Ratio	-	-	0.243	0.311	-	-
HCM Control Delay (s)	0	-	9.5	10.6	0	-
HCM Lane LOS	A	-	A	B	A	-
HCM 95th %tile Q(veh)	0	-	1	1	0	-

Intersection	
Int Delay, s/veh	

Movement	SBL	SBT	SBR
Vol, veh/h	0	13	261
Conflicting Peds, #/hr	0	0	0
Sign Control	Free	Free	Free
RT Channelized	-	-	Free
Storage Length	-	-	-
Veh in Median Storage, #	-	0	-
Grade, %	-	0	-
Peak Hour Factor	90	90	90
Heavy Vehicles, %	21	21	21
Mvmt Flow	0	14	290

Major/Minor	Major2		
Conflicting Flow All	182	0	0
Stage 1	-	-	-
Stage 2	-	-	-
Critical Hdwy	4.52	-	-
Critical Hdwy Stg 1	-	-	-
Critical Hdwy Stg 2	-	-	-
Follow-up Hdwy	2.41	-	-
Pot Cap-1 Maneuver	1263	-	0
Stage 1	-	-	0
Stage 2	-	-	0
Platoon blocked, %		-	
Mov Cap-1 Maneuver	1263	-	-
Mov Cap-2 Maneuver	-	-	-
Stage 1	-	-	-
Stage 2	-	-	-

Approach	SB
HCM Control Delay, s	
HCM LOS	

Minor Lane/Major Mvmt

Intersection	
Int Delay, s/veh	14

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR
Vol, veh/h	0	0	539	0	0	228	0	16	265
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0
Sign Control	Stop	Stop	Stop	Stop	Stop	Stop	Free	Free	Free
RT Channelized	-	-	Yield	-	-	Yield	-	-	Free
Storage Length	-	-	0	-	-	0	125	-	0
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-
Peak Hour Factor	90	90	90	90	90	90	90	90	90
Heavy Vehicles, %	2	2	2	8	8	8	13	13	13
Mvmt Flow	0	0	599	0	0	253	0	18	294

Major/Minor	Minor2			Minor1			Major1		
Conflicting Flow All	251	260	242	260	260	9	242	0	-
Stage 1	242	242	-	18	18	-	-	-	-
Stage 2	9	18	-	242	242	-	-	-	-
Critical Hdwy	7.33	6.53	6.23	7.42	6.62	7.02	4.23	-	-
Critical Hdwy Stg 1	6.13	5.53	-	6.62	5.62	-	-	-	-
Critical Hdwy Stg 2	6.53	5.53	-	6.22	5.62	-	-	-	-
Follow-up Hdwy	3.519	4.019	3.319	3.576	4.076	3.376	2.317	-	-
Pot Cap-1 Maneuver	692	644	796	668	632	1052	1263	-	0
Stage 1	761	705	-	983	868	-	-	-	0
Stage 2	1011	880	-	746	692	-	-	-	0
Platoon blocked, %								-	
Mov Cap-1 Maneuver	525	644	796	165	632	1052	1263	-	-
Mov Cap-2 Maneuver	525	644	-	165	632	-	-	-	-
Stage 1	761	705	-	983	868	-	-	-	-
Stage 2	768	880	-	185	692	-	-	-	-

Approach	EB	WB	NB
HCM Control Delay, s	21.9	9.5	
HCM LOS	C	A	

Minor Lane/Major Mvmt	NBL	NBT	EBLn1	WBLn1	SBL	SBT
Capacity (veh/h)	1263	-	796	1052	1488	-
HCM Lane V/C Ratio	-	-	0.752	0.241	-	-
HCM Control Delay (s)	0	-	21.9	9.5	0	-
HCM Lane LOS	A	-	C	A	A	-
HCM 95th %tile Q(veh)	0	-	7	1	0	-

Intersection			
Int Delay, s/veh			

Movement	SBL	SBT	SBR
Vol, veh/h	0	218	242
Conflicting Peds, #/hr	0	0	0
Sign Control	Free	Free	Free
RT Channelized	-	-	Free
Storage Length	-	-	-
Veh in Median Storage, #	-	0	-
Grade, %	-	0	-
Peak Hour Factor	90	90	90
Heavy Vehicles, %	18	18	18
Mvmt Flow	0	242	269

Major/Minor	Major2		
Conflicting Flow All	18	0	0
Stage 1	-	-	-
Stage 2	-	-	-
Critical Hdwy	4.46	-	-
Critical Hdwy Stg 1	-	-	-
Critical Hdwy Stg 2	-	-	-
Follow-up Hdwy	2.38	-	-
Pot Cap-1 Maneuver	1488	-	0
Stage 1	-	-	0
Stage 2	-	-	0
Platoon blocked, %		-	
Mov Cap-1 Maneuver	1488	-	-
Mov Cap-2 Maneuver	-	-	-
Stage 1	-	-	-
Stage 2	-	-	-

Approach	SB
HCM Control Delay, s	
HCM LOS	

Minor Lane/Major Mvmt

Intersection	
Int Delay, s/veh	2

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Vol, veh/h	29	218	56	33	347	78
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Stop	Stop	Free	Free
RT Channelized	-	Free	-	None	-	Yield
Storage Length	-	0	-	-	0	0
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	90	90	90	90	90	90
Heavy Vehicles, %	3	3	68	68	21	21
Mvmt Flow	32	242	62	37	386	87

Major/Minor	Major1		Minor2		Major2	
Conflicting Flow All	0	-	32	803	32	-
Stage 1	-	-	0	771	-	-
Stage 2	-	-	32	32	-	-
Critical Hdwy	-	-	7.08	7.18	4.31	-
Critical Hdwy Stg 1	-	-	-	-	-	-
Critical Hdwy Stg 2	-	-	6.08	6.18	-	-
Follow-up Hdwy	-	-	4.112	4.612	2.389	-
Pot Cap-1 Maneuver	-	0	837	252	1466	-
Stage 1	-	0	-	-	-	-
Stage 2	-	0	845	754	-	-
Platoon blocked, %	-					-
Mov Cap-1 Maneuver	-	-	617	0	1466	-
Mov Cap-2 Maneuver	-	-	617	0	-	-
Stage 1	-	-	-	0	-	-
Stage 2	-	-	845	0	-	-

Approach	EB	WB	NB
HCM Control Delay, s		11.9	
HCM LOS		B	

Minor Lane/Major Mvmt	NBL	NBR	EBT	WBLn1
Capacity (veh/h)	1466	-	-	617
HCM Lane V/C Ratio	0.263	-	-	0.16
HCM Control Delay (s)	8.3	-	-	11.9
HCM Lane LOS	A	-	-	B
HCM 95th %tile Q(veh)	1	-	-	1

Intersection	
Int Delay, s/veh	2.5

Movement	EBT	EBR	WBL	WBT	NBL	NBR
Vol, veh/h	35	399	61	23	182	62
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Free	Free	Stop	Stop	Free	Free
RT Channelized	-	Free	-	None	-	Yield
Storage Length	-	0	-	-	0	0
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	90	90	90	90	90	90
Heavy Vehicles, %	3	3	64	64	18	18
Mvmt Flow	39	443	68	26	202	69

Major/Minor	Major1		Minor2		Major2	
Conflicting Flow All	0	-	39	443	39	-
Stage 1	-	-	0	404	-	-
Stage 2	-	-	39	39	-	-
Critical Hdwy	-	-	7.04	7.14	4.28	-
Critical Hdwy Stg 1	-	-	-	-	-	-
Critical Hdwy Stg 2	-	-	6.04	6.14	-	-
Follow-up Hdwy	-	-	4.076	4.576	2.362	-
Pot Cap-1 Maneuver	-	0	837	427	1474	-
Stage 1	-	0	-	-	-	-
Stage 2	-	0	846	754	-	-
Platoon blocked, %	-					-
Mov Cap-1 Maneuver	-	-	722	0	1474	-
Mov Cap-2 Maneuver	-	-	722	0	-	-
Stage 1	-	-	-	0	-	-
Stage 2	-	-	846	0	-	-

Approach	EB	WB	NB
HCM Control Delay, s		10.7	
HCM LOS		B	

Minor Lane/Major Mvmt	NBL	NBR	EBT	WBLn1
Capacity (veh/h)	1474	-	-	722
HCM Lane V/C Ratio	0.137	-	-	0.129
HCM Control Delay (s)	7.8	-	-	10.7
HCM Lane LOS	A	-	-	B
HCM 95th %tile Q(veh)	0	-	-	0

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	7	667	122	41	268	4	171	5	118	4	4	5
Number	7	4	14	3	8	18	5	2	12	1	6	16
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1727	1727	1727	1712	1712	1900	1863	1863	1900	1863	1863	1900
Adj Flow Rate, veh/h	8	741	136	46	298	4	190	6	131	4	4	6
Adj No. of Lanes	1	2	1	1	2	0	1	2	0	1	2	0
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Percent Heavy Veh, %	10	10	10	11	11	11	2	2	2	2	2	2
Cap, veh/h	436	1234	552	237	1235	17	756	802	718	628	802	718
Arrive On Green	0.38	0.38	0.38	0.38	0.38	0.38	0.45	0.45	0.45	0.45	0.45	0.45
Sat Flow, veh/h	995	3282	1468	579	3286	44	1399	1770	1583	1247	1770	1583
Grp Volume(v), veh/h	8	741	136	46	147	155	190	6	131	4	4	6
Grp Sat Flow(s),veh/h/ln	995	1641	1468	579	1626	1704	1399	1770	1583	1247	1770	1583
Q Serve(g_s), s	0.3	10.5	3.7	4.0	3.6	3.6	5.0	0.1	2.9	0.1	0.1	0.1
Cycle Q Clear(g_c), s	3.9	10.5	3.7	14.6	3.6	3.6	5.1	0.1	2.9	3.0	0.1	0.1
Prop In Lane	1.00		1.00	1.00		0.03	1.00		1.00	1.00		1.00
Lane Grp Cap(c), veh/h	436	1234	552	237	611	641	756	802	718	628	802	718
V/C Ratio(X)	0.02	0.60	0.25	0.19	0.24	0.24	0.25	0.01	0.18	0.01	0.00	0.01
Avail Cap(c_a), veh/h	509	1474	660	279	730	765	756	802	718	628	802	718
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	13.7	14.6	12.4	20.4	12.4	12.4	10.1	8.7	9.4	10.3	8.7	8.7
Incr Delay (d2), s/veh	0.0	0.5	0.2	0.4	0.2	0.2	0.8	0.0	0.6	0.0	0.0	0.0
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	0.1	4.8	1.5	0.7	1.6	1.7	2.1	0.1	1.3	0.0	0.0	0.1
LnGrp Delay(d),s/veh	13.8	15.0	12.7	20.8	12.6	12.6	10.9	8.7	10.0	10.3	8.7	8.7
LnGrp LOS	B	B	B	C	B	B	B	A	A	B	A	A
Approach Vol, veh/h		885			348			327			14	
Approach Delay, s/veh		14.7			13.7			10.5			9.2	
Approach LOS		B			B			B			A	

Timer	1	2	3	4	5	6	7	8
Assigned Phs		2		4		6		8
Phs Duration (G+Y+Rc), s		32.2		27.8		32.2		27.8
Change Period (Y+Rc), s		6.0		6.0		6.0		6.0
Max Green Setting (Gmax), s		22.0		26.0		22.0		26.0
Max Q Clear Time (g_c+I1), s		7.1		12.5		5.0		16.6
Green Ext Time (p_c), s		1.2		6.6		1.3		5.2

Intersection Summary	
HCM 2010 Ctrl Delay	13.5
HCM 2010 LOS	B

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Volume (veh/h)	5	279	172	123	567	4	140	4	38	4	5	9
Number	7	4	14	3	8	18	5	2	12	1	6	16
Initial Q (Qb), veh	0	0	0	0	0	0	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00		1.00	1.00		1.00	1.00		1.00	1.00		1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1743	1743	1743	1712	1712	1900	1863	1863	1900	1863	1863	1900
Adj Flow Rate, veh/h	6	310	191	137	630	4	156	4	42	4	6	10
Adj No. of Lanes	1	2	1	1	2	0	1	2	0	1	2	0
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90	0.90
Percent Heavy Veh, %	9	9	9	11	11	11	2	2	2	2	2	2
Cap, veh/h	266	1140	510	353	1141	7	806	871	780	773	871	780
Arrive On Green	0.34	0.34	0.34	0.34	0.34	0.34	0.49	0.49	0.49	0.49	0.49	0.49
Sat Flow, veh/h	739	3312	1482	821	3313	21	1392	1770	1583	1354	1770	1583
Grp Volume(v), veh/h	6	310	191	137	309	325	156	4	42	4	6	10
Grp Sat Flow(s),veh/h/ln	739	1656	1482	821	1626	1708	1392	1770	1583	1354	1770	1583
Q Serve(g_s), s	0.4	3.9	5.6	8.3	8.8	8.8	3.7	0.1	0.8	0.1	0.1	0.2
Cycle Q Clear(g_c), s	9.2	3.9	5.6	12.2	8.8	8.8	3.9	0.1	0.8	0.9	0.1	0.2
Prop In Lane	1.00		1.00	1.00		0.01	1.00		1.00	1.00		1.00
Lane Grp Cap(c), veh/h	266	1140	510	353	560	588	806	871	780	773	871	780
V/C Ratio(X)	0.02	0.27	0.37	0.39	0.55	0.55	0.19	0.00	0.05	0.01	0.01	0.01
Avail Cap(c_a), veh/h	334	1443	646	428	709	744	806	871	780	773	871	780
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Uniform Delay (d), s/veh	19.0	13.6	14.2	18.0	15.2	15.2	8.4	7.4	7.6	7.8	7.4	7.4
Incr Delay (d2), s/veh	0.0	0.1	0.5	0.7	0.9	0.8	0.5	0.0	0.1	0.0	0.0	0.0
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	0.1	1.8	2.3	1.9	4.1	4.3	1.5	0.0	0.4	0.0	0.1	0.1
LnGrp Delay(d),s/veh	19.0	13.7	14.6	18.7	16.1	16.0	9.0	7.4	7.7	7.8	7.4	7.5
LnGrp LOS	B	B	B	B	B	B	A	A	A	A	A	A
Approach Vol, veh/h		507			771			202			20	
Approach Delay, s/veh		14.1			16.5			8.7			7.5	
Approach LOS		B			B			A			A	

Timer	1	2	3	4	5	6	7	8
Assigned Phs		2		4		6		8
Phs Duration (G+Y+Rc), s		34.2		25.8		34.2		25.8
Change Period (Y+Rc), s		6.0		6.0		6.0		6.0
Max Green Setting (Gmax), s		23.0		25.0		23.0		25.0
Max Q Clear Time (g_c+I1), s		5.9		11.2		2.9		14.2
Green Ext Time (p_c), s		0.7		6.5		0.7		5.6

Intersection Summary	
HCM 2010 Ctrl Delay	14.5
HCM 2010 LOS	B

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Volume (veh/h)	76	14	7	218	113	54
Number	7	14	5	2	6	16
Initial Q (Qb), veh	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00	1.00	1.00			1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1863	1863	1863	1863	1863	1900
Adj Flow Rate, veh/h	84	16	8	242	126	60
Adj No. of Lanes	2	1	1	2	2	0
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90
Percent Heavy Veh, %	2	2	2	2	2	2
Cap, veh/h	443	204	1029	2661	1782	806
Arrive On Green	0.13	0.13	0.75	0.75	0.75	0.75
Sat Flow, veh/h	3442	1583	1193	3632	2463	1073
Grp Volume(v), veh/h	84	16	8	242	92	94
Grp Sat Flow(s),veh/h/ln	1721	1583	1193	1770	1770	1673
Q Serve(g_s), s	1.2	0.5	0.1	1.0	0.7	0.8
Cycle Q Clear(g_c), s	1.2	0.5	0.1	1.0	0.7	0.8
Prop In Lane	1.00	1.00	1.00			0.64
Lane Grp Cap(c), veh/h	443	204	1029	2661	1330	1258
V/C Ratio(X)	0.19	0.08	0.01	0.09	0.07	0.07
Avail Cap(c_a), veh/h	1136	523	1029	2661	1330	1258
HCM Platoon Ratio	1.00	1.00	1.00	1.00	1.00	1.00
Upstream Filter(I)	1.00	1.00	1.00	1.00	0.98	0.98
Uniform Delay (d), s/veh	21.2	20.9	1.7	1.8	1.8	1.8
Incr Delay (d2), s/veh	0.2	0.2	0.0	0.1	0.1	0.1
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	0.6	0.2	0.0	0.5	0.4	0.4
LnGrp Delay(d),s/veh	21.4	21.1	1.7	1.9	1.9	1.9
LnGrp LOS	C	C	A	A	A	A
Approach Vol, veh/h	100			250	186	
Approach Delay, s/veh	21.4			1.9	1.9	
Approach LOS	C			A	A	

Timer	1	2	3	4	5	6	7	8
Assigned Phs		2		4		6		
Phs Duration (G+Y+Rc), s		47.0		13.0		47.0		
Change Period (Y+Rc), s		6.0		6.0		6.0		
Max Green Setting (Gmax), s		30.0		18.0		30.0		
Max Q Clear Time (g_c+I1), s		3.1		3.2		2.8		
Green Ext Time (p_c), s		2.7		0.2		2.7		

Intersection Summary	
HCM 2010 Ctrl Delay	5.5
HCM 2010 LOS	A

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Lane Configurations						
Volume (veh/h)	56	7	8	126	228	72
Number	7	14	5	2	6	16
Initial Q (Qb), veh	0	0	0	0	0	0
Ped-Bike Adj(A_pbT)	1.00	1.00	1.00			1.00
Parking Bus, Adj	1.00	1.00	1.00	1.00	1.00	1.00
Adj Sat Flow, veh/h/ln	1863	1863	1863	1863	1863	1900
Adj Flow Rate, veh/h	62	8	9	140	253	80
Adj No. of Lanes	2	1	1	2	2	0
Peak Hour Factor	0.90	0.90	0.90	0.90	0.90	0.90
Percent Heavy Veh, %	2	2	2	2	2	2
Cap, veh/h	372	171	939	2739	2061	637
Arrive On Green	0.11	0.11	0.77	0.77	1.00	1.00
Sat Flow, veh/h	3442	1583	1043	3632	2757	823
Grp Volume(v), veh/h	62	8	9	140	166	167
Grp Sat Flow(s),veh/h/ln	1721	1583	1043	1770	1770	1717
Q Serve(g_s), s	0.9	0.2	0.1	0.5	0.0	0.0
Cycle Q Clear(g_c), s	0.9	0.2	0.1	0.5	0.0	0.0
Prop In Lane	1.00	1.00	1.00			0.48
Lane Grp Cap(c), veh/h	372	171	939	2739	1369	1329
V/C Ratio(X)	0.17	0.05	0.01	0.05	0.12	0.13
Avail Cap(c_a), veh/h	1075	494	939	2739	1369	1329
HCM Platoon Ratio	1.00	1.00	1.00	1.00	2.00	2.00
Upstream Filter(I)	1.00	1.00	1.00	1.00	0.95	0.95
Uniform Delay (d), s/veh	22.1	21.8	1.4	1.5	0.0	0.0
Incr Delay (d2), s/veh	0.2	0.1	0.0	0.0	0.2	0.2
Initial Q Delay(d3),s/veh	0.0	0.0	0.0	0.0	0.0	0.0
%ile BackOfQ(50%),veh/ln	0.4	0.1	0.0	0.2	0.1	0.1
LnGrp Delay(d),s/veh	22.3	21.9	1.4	1.5	0.2	0.2
LnGrp LOS	C	C	A	A	A	A
Approach Vol, veh/h	70			149	333	
Approach Delay, s/veh	22.2			1.5	0.2	
Approach LOS	C			A	A	

Timer	1	2	3	4	5	6	7	8
Assigned Phs		2		4		6		
Phs Duration (G+Y+Rc), s		48.1		11.9		48.1		
Change Period (Y+Rc), s		6.0		6.0		6.0		
Max Green Setting (Gmax), s		31.0		17.0		31.0		
Max Q Clear Time (g_c+I1), s		3.5		2.9		2.0		
Green Ext Time (p_c), s		2.9		0.1		3.0		

Intersection Summary	
HCM 2010 Ctrl Delay	3.3
HCM 2010 LOS	A

Intersection	
Int Delay, s/veh	0.3

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Vol, veh/h	0	0	12	225	14	113
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	0	-	-	-	-	-
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	90	90	90	90	90	90
Heavy Vehicles, %	2	2	2	2	2	2
Mvmt Flow	0	0	13	250	16	126

Major/Minor	Minor2		Major1		Major2	
Conflicting Flow All	230	71	141	0	-	0
Stage 1	78	-	-	-	-	-
Stage 2	152	-	-	-	-	-
Critical Hdwy	6.84	6.94	4.14	-	-	-
Critical Hdwy Stg 1	5.84	-	-	-	-	-
Critical Hdwy Stg 2	5.84	-	-	-	-	-
Follow-up Hdwy	3.52	3.32	2.22	-	-	-
Pot Cap-1 Maneuver	738	977	1440	-	-	-
Stage 1	936	-	-	-	-	-
Stage 2	860	-	-	-	-	-
Platoon blocked, %				-	-	-
Mov Cap-1 Maneuver	731	977	1440	-	-	-
Mov Cap-2 Maneuver	731	-	-	-	-	-
Stage 1	936	-	-	-	-	-
Stage 2	851	-	-	-	-	-

Approach	EB	NB	SB
HCM Control Delay, s	0	0.4	
HCM LOS	A		

Minor Lane/Major Mvmt	NBL	NBT	EBLn1	SBT	SBR
Capacity (veh/h)	1440	-	-	-	-
HCM Lane V/C Ratio	0.009	-	-	-	-
HCM Control Delay (s)	7.5	0	0	-	-
HCM Lane LOS	A	A	A	-	-
HCM 95th %tile Q(veh)	0	-	-	-	-

Intersection	
Int Delay, s/veh	0.1

Movement	EBL	EBR	NBL	NBT	SBT	SBR
Vol, veh/h	0	0	4	134	14	221
Conflicting Peds, #/hr	0	0	0	0	0	0
Sign Control	Stop	Stop	Free	Free	Free	Free
RT Channelized	-	None	-	None	-	None
Storage Length	0	-	-	-	-	-
Veh in Median Storage, #	0	-	-	0	0	-
Grade, %	0	-	-	0	0	-
Peak Hour Factor	90	90	90	90	90	90
Heavy Vehicles, %	2	2	2	2	2	2
Mvmt Flow	0	0	4	149	16	246

Major/Minor	Minor2		Major1		Major2	
Conflicting Flow All	221	131	261	0	-	0
Stage 1	138	-	-	-	-	-
Stage 2	83	-	-	-	-	-
Critical Hdwy	6.84	6.94	4.14	-	-	-
Critical Hdwy Stg 1	5.84	-	-	-	-	-
Critical Hdwy Stg 2	5.84	-	-	-	-	-
Follow-up Hdwy	3.52	3.32	2.22	-	-	-
Pot Cap-1 Maneuver	747	894	1300	-	-	-
Stage 1	874	-	-	-	-	-
Stage 2	931	-	-	-	-	-
Platoon blocked, %				-	-	-
Mov Cap-1 Maneuver	745	894	1300	-	-	-
Mov Cap-2 Maneuver	745	-	-	-	-	-
Stage 1	874	-	-	-	-	-
Stage 2	928	-	-	-	-	-

Approach	EB	NB	SB
HCM Control Delay, s	0	0.2	
HCM LOS	A		

Minor Lane/Major Mvmt	NBL	NBT	EBLn1	SBT	SBR
Capacity (veh/h)	1300	-	-	-	-
HCM Lane V/C Ratio	0.003	-	-	-	-
HCM Control Delay (s)	7.8	0	0	-	-
HCM Lane LOS	A	A	A	-	-
HCM 95th %tile Q(veh)	0	-	-	-	-

Intersection	
Int Delay, s/veh	9.1

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR
Vol, veh/h	221	4	4	4	0	8	0	8	4
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0
Sign Control	Stop	Stop	Stop	Stop	Stop	Stop	Free	Free	Free
RT Channelized	-	-	None	-	-	None	-	-	None
Storage Length	-	-	-	-	-	-	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-
Peak Hour Factor	90	90	90	90	90	90	90	90	90
Heavy Vehicles, %	2	2	2	2	2	2	2	2	2
Mvmt Flow	246	4	4	4	0	9	0	9	4

Major/Minor	Minor2			Minor1			Major1		
Conflicting Flow All	43	40	4	42	38	11	4	0	0
Stage 1	27	27	-	11	11	-	-	-	-
Stage 2	16	13	-	31	27	-	-	-	-
Critical Hdwy	7.12	6.52	6.22	7.12	6.52	6.22	4.12	-	-
Critical Hdwy Stg 1	6.12	5.52	-	6.12	5.52	-	-	-	-
Critical Hdwy Stg 2	6.12	5.52	-	6.12	5.52	-	-	-	-
Follow-up Hdwy	3.518	4.018	3.318	3.518	4.018	3.318	2.218	-	-
Pot Cap-1 Maneuver	960	852	1080	961	854	1070	1618	-	-
Stage 1	990	873	-	1010	886	-	-	-	-
Stage 2	1004	885	-	986	873	-	-	-	-
Platoon blocked, %								-	-
Mov Cap-1 Maneuver	947	846	1080	948	848	1070	1618	-	-
Mov Cap-2 Maneuver	947	846	-	948	848	-	-	-	-
Stage 1	990	867	-	1010	886	-	-	-	-
Stage 2	996	885	-	970	867	-	-	-	-

Approach	EB	WB	NB
HCM Control Delay, s	10.2	8.6	
HCM LOS	B	A	

Minor Lane/Major Mvmt	NBL	NBT	NBR	EBLn1	WBLn1	SBL	SBT	SBR
Capacity (veh/h)	1618	-	-	947	1026	1606	-	-
HCM Lane V/C Ratio	-	-	-	0.269	0.013	0.007	-	-
HCM Control Delay (s)	0	-	-	10.2	8.6	7.3	-	-
HCM Lane LOS	A	-	-	B	A	A	-	-
HCM 95th %tile Q(veh)	0	-	-	1	0	0	-	-

Intersection	
Int Delay, s/veh	

Movement	SBL	SBT	SBR
Vol, veh/h	10	4	0
Conflicting Peds, #/hr	0	0	0
Sign Control	Free	Free	Free
RT Channelized	-	-	None
Storage Length	0	-	-
Veh in Median Storage, #	-	0	-
Grade, %	-	0	-
Peak Hour Factor	90	90	90
Heavy Vehicles, %	2	2	2
Mvmt Flow	11	4	0

Major/Minor	Major2		
Conflicting Flow All	13	0	0
Stage 1	-	-	-
Stage 2	-	-	-
Critical Hdwy	4.12	-	-
Critical Hdwy Stg 1	-	-	-
Critical Hdwy Stg 2	-	-	-
Follow-up Hdwy	2.218	-	-
Pot Cap-1 Maneuver	1606	-	-
Stage 1	-	-	-
Stage 2	-	-	-
Platoon blocked, %		-	-
Mov Cap-1 Maneuver	1606	-	-
Mov Cap-2 Maneuver	-	-	-
Stage 1	-	-	-
Stage 2	-	-	-

Approach	SB
HCM Control Delay, s	
HCM LOS	

Minor Lane/Major Mvmt

Intersection	
Int Delay, s/veh	8.1

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR
Vol, veh/h	128	4	4	4	0	4	0	6	4
Conflicting Peds, #/hr	0	0	0	0	0	0	0	0	0
Sign Control	Stop	Stop	Stop	Stop	Stop	Stop	Free	Free	Free
RT Channelized	-	-	None	-	-	None	-	-	None
Storage Length	-	-	-	-	-	-	-	-	-
Veh in Median Storage, #	-	0	-	-	0	-	-	0	-
Grade, %	-	0	-	-	0	-	-	0	-
Peak Hour Factor	90	90	90	90	90	90	90	90	90
Heavy Vehicles, %	2	2	2	2	2	2	2	2	2
Mvmt Flow	142	4	4	4	0	4	0	7	4

Major/Minor	Minor2			Minor1			Major1		
Conflicting Flow All	38	38	4	40	36	9	4	0	0
Stage 1	27	27	-	9	9	-	-	-	-
Stage 2	11	11	-	31	27	-	-	-	-
Critical Hdwy	7.12	6.52	6.22	7.12	6.52	6.22	4.12	-	-
Critical Hdwy Stg 1	6.12	5.52	-	6.12	5.52	-	-	-	-
Critical Hdwy Stg 2	6.12	5.52	-	6.12	5.52	-	-	-	-
Follow-up Hdwy	3.518	4.018	3.318	3.518	4.018	3.318	2.218	-	-
Pot Cap-1 Maneuver	967	854	1080	964	856	1073	1618	-	-
Stage 1	990	873	-	1012	888	-	-	-	-
Stage 2	1010	886	-	986	873	-	-	-	-
Platoon blocked, %								-	-
Mov Cap-1 Maneuver	958	848	1080	951	850	1073	1618	-	-
Mov Cap-2 Maneuver	958	848	-	951	850	-	-	-	-
Stage 1	990	867	-	1012	888	-	-	-	-
Stage 2	1006	886	-	970	867	-	-	-	-

Approach	EB	WB	NB
HCM Control Delay, s	9.5	8.6	
HCM LOS	A	A	

Minor Lane/Major Mvmt	NBL	NBT	NBR	EBLn1	WBLn1	SBL	SBT	SBR
Capacity (veh/h)	1618	-	-	958	1008	1608	-	-
HCM Lane V/C Ratio	-	-	-	0.158	0.009	0.007	-	-
HCM Control Delay (s)	0	-	-	9.5	8.6	7.3	-	-
HCM Lane LOS	A	-	-	A	A	A	-	-
HCM 95th %tile Q(veh)	0	-	-	1	0	0	-	-

Intersection	
Int Delay, s/veh	

Movement	SBL	SBT	SBR
Vol, veh/h	10	4	0
Conflicting Peds, #/hr	0	0	0
Sign Control	Free	Free	Free
RT Channelized	-	-	None
Storage Length	0	-	-
Veh in Median Storage, #	-	0	-
Grade, %	-	0	-
Peak Hour Factor	90	90	90
Heavy Vehicles, %	2	2	2
Mvmt Flow	11	4	0

Major/Minor	Major2		
Conflicting Flow All	11	0	0
Stage 1	-	-	-
Stage 2	-	-	-
Critical Hdwy	4.12	-	-
Critical Hdwy Stg 1	-	-	-
Critical Hdwy Stg 2	-	-	-
Follow-up Hdwy	2.218	-	-
Pot Cap-1 Maneuver	1608	-	-
Stage 1	-	-	-
Stage 2	-	-	-
Platoon blocked, %		-	-
Mov Cap-1 Maneuver	1608	-	-
Mov Cap-2 Maneuver	-	-	-
Stage 1	-	-	-
Stage 2	-	-	-

Approach	SB
HCM Control Delay, s	
HCM LOS	

Minor Lane/Major Mvmt

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	Cosgrove NB
Agency or Company	Atkins	Junction	7010 - Off to I-26 EB
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2038 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Number of Lanes, N: 3	☐ Yes ☐ On
☑ No ☐ Off	Acceleration Lane Length, L_A:	☑ No ☐ Off
L_{up} = ft	Deceleration Lane Length L_D: 125	L_{down} = ft
V_u = veh/h	Freeway Volume, V_F: 3139	V_D = veh/h
	Ramp Volume, V_R: 899	
	Freeway Free-Flow Speed, S_{FF}: 55.0	
	Ramp Free-Flow Speed, S_{FR}: 45.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	3139	0.90	Level	12	0	0.943	1.00	3697
Ramp	899	0.90	Level	16	0	0.926	1.00	1079
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 0.618 using Equation (Exhibit 13-7)

V_{12} = 2697 pc/h

V_3 or V_{av34} 1000 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	3697	Exhibit 13-8	6750	No
$V_{FO} = V_F - V_R$	2618	Exhibit 13-8	6750	No
V_R	1079	Exhibit 13-10	2100	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	2697	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = 26.3 (pc/mi/ln)

LOS = C (Exhibit 13-2)

Speed Determination

D_s = 0.395 (Exhibit 13-12)

S_R= 49.9 mph (Exhibit 13-12)

S_0= 60.3 mph (Exhibit 13-12)

S = 52.3 mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	10	Freeway/Dir of Travel	Cosgrove NB
Agency or Company	Atkins	Junction	7010 - Off to I-26 EB
Date Performed	3/20/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2038 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Number of Lanes, N	3	Downstream Adj Ramp	
☐ Yes	☐ On	Acceleration Lane Length, L_A		☐ Yes	☐ On
☑ No	☐ Off	Deceleration Lane Length L_D	125	☑ No	☐ Off
L_{up} =	ft	Freeway Volume, V_F	2076	L_{down} =	ft
V_u =	veh/h	Ramp Volume, V_R	485	V_D =	veh/h
		Freeway Free-Flow Speed, S_{FF}	55.0		
		Ramp Free-Flow Speed, S_{FR}	45.0		

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	2076	0.90	Level	10	0	0.952	1.00	2422
Ramp	485	0.90	Level	26	0	0.885	1.00	609
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 0.671 using Equation (Exhibit 13-7)

V_{12} = 1826 pc/h

V_3 or V_{av34} 596 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	2422	Exhibit 13-8	6750	No
$V_{FO} = V_F - V_R$	1813	Exhibit 13-8	6750	No
V_R	609	Exhibit 13-10	2100	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	1826	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = 18.8 (pc/mi/ln)

LOS = B (Exhibit 13-2)

Speed Determination

D_s = 0.353 (Exhibit 13-12)

S_R= 50.4 mph (Exhibit 13-12)

S_0= 60.3 mph (Exhibit 13-12)

S = 52.5 mph (Exhibit 13-13)

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Navy Base ICTF

FREEWAY WEAVING WORKSHEET

General Information

Analyst	AJR
Agency/Company	Atkins
Date Performed	7/25/2014
Analysis Time Period	AM Peak

Site Information

Freeway/Dir of Travel	Cosgrove NB
Weaving Segment Location	7020-I-26 EB On to I-26 WB Off
Analysis Year	2038 No Action

Project Description *Navy Base ICTF*

Inputs

Weaving configuration	One-Sided
Weaving number of lanes, N	4
Weaving segment length, L_S	450ft
Freeway free-flow speed, FFS	45 mph
Segment type	C-D Roadway/ Multilane Highways
Freeway minimum speed, S_{MIN}	15
Freeway maximum capacity, C_{IFL}	2250
Terrain type	Level

Conversions to pc/h Under Base Conditions

	V (veh/h)	PHF	Truck (%)	RV (%)	E_T	E_R	f_{HV}	f_p	v (pc/h)
V_{FF}	1371	0.90	10	0	1.5	1.2	0.952	1.00	1600
V_{RF}	303	0.90	10	0	1.5	1.2	0.952	1.00	354
V_{FR}	869	0.90	19	0	1.5	1.2	0.913	1.00	1057
V_{RR}	0	0.90	0	0	1.5	1.2	1.000	1.00	0
V_{NW}	1600							V =	3011
V_W	1411								
VR	0.469								

Configuration Characteristics

Minimum maneuver lanes, N_{WL}	2 lc	Minimum weaving lane changes, LC_{MIN}	1411 lc/h
Interchange density, ID	0.2 int/mi	Weaving lane changes, LC_W	1499 lc/h
Minimum RF lane changes, LC_{RF}	1 lc/pc	Non-weaving lane changes, LC_{NW}	0 lc/h
Minimum FR lane changes, LC_{FR}	1 lc/pc	Total lane changes, LC_{ALL}	1499 lc/h
Minimum RR lane changes, LC_{RR}	lc/pc	Non-weaving vehicle index, I_{NW}	14

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment flow rate, v	3011 pc/h	Weaving intensity factor, W	0.584
Weaving segment capacity, c_w	4878 veh/h	Weaving segment speed, S	32.4 mph
Weaving segment v/c ratio	0.588	Average weaving speed, S_W	33.9 mph
Weaving segment density, D	23.2 pc/mi/ln	Average non-weaving speed, S_{NW}	31.2 mph
Level of Service, LOS	B	Maximum weaving length, L_{MAX}	7462 ft

Notes

a. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments".
b. For volumes that exceed the weaving segment capacity, the level of service is "F".

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Navy Base ICTF

FREEWAY WEAVING WORKSHEET

General Information

Analyst	AJR
Agency/Company	Atkins
Date Performed	7/25/2014
Analysis Time Period	PM Peak

Site Information

Freeway/Dir of Travel	Cosgrove NB
Weaving Segment Location	7020-I-26 EB On to I-26 WB Off
Analysis Year	2038 No Action

Project Description *Navy Base ICTF*

Inputs

Weaving configuration	One-Sided
Weaving number of lanes, N	4
Weaving segment length, L_S	450ft
Freeway free-flow speed, FFS	45 mph
Segment type	C-D Roadway/ Multilane Highways
Freeway minimum speed, S_{MIN}	15
Freeway maximum capacity, C_{IFL}	2250
Terrain type	Level

Conversions to pc/h Under Base Conditions

	V (veh/h)	PHF	Truck (%)	RV (%)	E_T	E_R	f_{HV}	f_p	v (pc/h)
V_{FF}	801	0.90	8	0	1.5	1.2	0.962	1.00	926
V_{RF}	143	0.90	14	0	1.5	1.2	0.935	1.00	170
V_{FR}	790	0.90	18	0	1.5	1.2	0.917	1.00	957
V_{RR}	0	0.90	0	0	1.5	1.2	1.000	1.00	0
V_{NW}	926							V =	2053
V_W	1127								
VR	0.549								

Configuration Characteristics

Minimum maneuver lanes, N_{WL}	2 lc	Minimum weaving lane changes, LC_{MIN}	1127 lc/h
Interchange density, ID	0.2 int/mi	Weaving lane changes, LC_W	1215 lc/h
Minimum RF lane changes, LC_{RF}	1 lc/pc	Non-weaving lane changes, LC_{NW}	0 lc/h
Minimum FR lane changes, LC_{FR}	1 lc/pc	Total lane changes, LC_{ALL}	1215 lc/h
Minimum RR lane changes, LC_{RR}	lc/pc	Non-weaving vehicle index, I_{NW}	8

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment flow rate, v	2053 pc/h	Weaving intensity factor, W	0.495
Weaving segment capacity, c_w	4204 veh/h	Weaving segment speed, S	34.8 mph
Weaving segment v/c ratio	0.470	Average weaving speed, S_W	35.1 mph
Weaving segment density, D	14.8 pc/mi/ln	Average non-weaving speed, S_{NW}	34.4 mph
Level of Service, LOS	B	Maximum weaving length, L_{MAX}	8404 ft

Notes

a. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments".
b. For volumes that exceed the weaving segment capacity, the level of service is "F".

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	Cosgrove NB
Agency or Company	Atkins	Junction	7030 - NB On from I-26 WB
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2038 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Number of Lanes, N: 3	☐ Yes ☐ On
☑ No ☐ Off	Acceleration Lane Length, L_A: 200	☑ No ☐ Off
L_{up} = ft	Deceleration Lane Length L_D:	L_{down} = ft
V_u = veh/h	Freeway Volume, V_F: 1674	V_D = veh/h
	Ramp Volume, V_R: 459	
	Freeway Free-Flow Speed, S_{FF}: 55.0	
	Ramp Free-Flow Speed, S_{FR}: 45.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	1674	0.90	Level	10	0	0.952	1.00	1953
Ramp	459	0.90	Level	13	0	0.939	1.00	543
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 0.583 using Equation (Exhibit 13-6)

V_{12} = 1139 pc/h

V_3 or V_{av34} 814 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * $V_{12}/2$ ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	2496	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	1682	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = 17.1 (pc/mi/ln)

LOS = B (Exhibit 13-2)

Speed Determination

M_S = 0.324 (Exibit 13-11)

S_R= 50.8 mph (Exhibit 13-11)

S_0= 53.9 mph (Exhibit 13-11)

S = 51.8 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * $V_{12}/2$ ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	Cosgrove NB
Agency or Company	Atkins	Junction	7030 - NB On from I-26 WB
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2038 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Number of Lanes, N: 3	☐ Yes ☐ On
☑ No ☐ Off	Acceleration Lane Length, L_A: 200	☑ No ☐ Off
L_{up} = ft	Deceleration Lane Length L_D:	L_{down} = ft
V_u = veh/h	Freeway Volume, V_F: 944	V_D = veh/h
	Ramp Volume, V_R: 419	
	Freeway Free-Flow Speed, S_{FF}: 55.0	
	Ramp Free-Flow Speed, S_{FR}: 45.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	944	0.90	Level	8	0	0.962	1.00	1091
Ramp	419	0.90	Level	12	0	0.943	1.00	493
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 0.583 using Equation (Exhibit 13-6)

V_{12} = 636 pc/h

V_3 or V_{av34} 455 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	1584	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	1129	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = 12.8 (pc/mi/ln)

LOS = B (Exhibit 13-2)

Speed Determination

M_S = 0.315 (Exibit 13-11)

S_R= 50.9 mph (Exhibit 13-11)

S_0= 55.0 mph (Exhibit 13-11)

S = 52.0 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	Cosgrove SB
Agency or Company	Atkins	Junction	7040 - Off to I-26 WB
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2038 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Number of Lanes, N	2	Downstream Adj Ramp	
☐ Yes	☐ On	Acceleration Lane Length, L_A		☐ Yes	☐ On
☑ No	☐ Off	Deceleration Lane Length L_D	225	☑ No	☐ Off
L_{up} =	ft	Freeway Volume, V_F	1123	L_{down} =	ft
		Ramp Volume, V_R	167		
		Freeway Free-Flow Speed, S_{FF}	55.0		
V_u =	veh/h	Ramp Free-Flow Speed, S_{FR}	45.0	V_D =	veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	1123	0.90	Level	5	0	0.976	1.00	1279
Ramp	167	0.90	Level	25	0	0.889	1.00	209
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 1.000 using Equation (Exhibit 13-7)

V_{12} = 1279 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	1279	Exhibit 13-8	4500	No
$V_{FO} = V_F - V_R$	1070	Exhibit 13-8	4500	No
V_R	209	Exhibit 13-10	2100	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	1279	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = 13.2 (pc/mi/ln)

LOS = B (Exhibit 13-2)

Speed Determination

D_s = 0.317 (Exhibit 13-12)

S_R= 50.9 mph (Exhibit 13-12)

S_0= N/A mph (Exhibit 13-12)

S = 50.9 mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	Cosgrove SB
Agency or Company	Atkins	Junction	7040 - Off to I-26 WB
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2038 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Number of Lanes, N	2	Downstream Adj Ramp	
☐ Yes	☐ On	Acceleration Lane Length, L_A		☐ Yes	☐ On
☑ No	☐ Off	Deceleration Lane Length L_D	225	☑ No	☐ Off
L_{up} =	ft	Freeway Volume, V_F	1975	L_{down} =	ft
		Ramp Volume, V_R	344		
		Freeway Free-Flow Speed, S_{FF}	55.0		
V_u =	veh/h	Ramp Free-Flow Speed, S_{FR}	45.0	V_D =	veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	1975	0.90	Level	4	0	0.980	1.00	2238
Ramp	344	0.90	Level	10	0	0.952	1.00	401
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 1.000 using Equation (Exhibit 13-7)

V_{12} = 2238 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	2238	Exhibit 13-8	4500	No
$V_{FO} = V_F - V_R$	1837	Exhibit 13-8	4500	No
V_R	401	Exhibit 13-10	2100	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	2238	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = 21.5 (pc/mi/ln)

LOS = C (Exhibit 13-2)

Speed Determination

D_s = 0.334 (Exhibit 13-12)

S_R= 50.7 mph (Exhibit 13-12)

S_0= N/A mph (Exhibit 13-12)

S = 50.7 mph (Exhibit 13-13)

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Navy Base ICTF

FREEWAY WEAVING WORKSHEET

General Information

Analyst	AJR
Agency/Company	Atkins
Date Performed	7/25/2014
Analysis Time Period	AM Peak

Site Information

Freeway/Dir of Travel	Cosgrove SB
Weaving Segment Location	7050-I-26 WB On to I-26 EB Off
Analysis Year	2038 No Action

Project Description *Navy Base ICTF*

Inputs

Weaving configuration	One-Sided
Weaving number of lanes, N	3
Weaving segment length, L_S	475ft
Freeway free-flow speed, FFS	45 mph
Segment type	C-D Roadway/ Multilane Highways
Freeway minimum speed, S_{MIN}	15
Freeway maximum capacity, C_{IFL}	2250
Terrain type	Level

Conversions to pc/h Under Base Conditions

	V (veh/h)	PHF	Truck (%)	RV (%)	E_T	E_R	f_{HV}	f_p	v (pc/h)
V_{FF}	516	0.90	10	0	1.5	1.2	0.952	1.00	602
V_{RF}	378	0.90	28	0	1.5	1.2	0.877	1.00	479
V_{FR}	440	0.90	10	0	1.5	1.2	0.952	1.00	513
V_{RR}	0	0.90	0	0	1.5	1.2	1.000	1.00	0
V_{NW}	602							V =	1594
V_W	992								
VR	0.622								

Configuration Characteristics

Minimum maneuver lanes, N_{WL}	2 lc	Minimum weaving lane changes, LC_{MIN}	992 lc/h
Interchange density, ID	0.2 int/mi	Weaving lane changes, LC_W	1046 lc/h
Minimum RF lane changes, LC_{RF}	1 lc/pc	Non-weaving lane changes, LC_{NW}	0 lc/h
Minimum FR lane changes, LC_{FR}	1 lc/pc	Total lane changes, LC_{ALL}	1046 lc/h
Minimum RR lane changes, LC_{RR}	lc/pc	Non-weaving vehicle index, I_{NW}	6

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment flow rate, v	1594 pc/h	Weaving intensity factor, W	0.421
Weaving segment capacity, c_w	3673 veh/h	Weaving segment speed, S	35.8 mph
Weaving segment v/c ratio	0.413	Average weaving speed, S_W	36.1 mph
Weaving segment density, D	14.8 pc/mi/ln	Average non-weaving speed, S_{NW}	35.3 mph
Level of Service, LOS	B	Maximum weaving length, L_{MAX}	9291 ft

Notes

a. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments".
b. For volumes that exceed the weaving segment capacity, the level of service is "F".

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Navy Base ICTF

FREEWAY WEAVING WORKSHEET

General Information

Analyst	AJR
Agency/Company	Atkins
Date Performed	7/25/2014
Analysis Time Period	PM Peak

Site Information

Freeway/Dir of Travel	Cosgrove SB
Weaving Segment Location	7050-I-26 WB On to I-26 EB Off
Analysis Year	2038 No Action

Project Description *Navy Base ICTF*

Inputs

Weaving configuration	One-Sided
Weaving number of lanes, N	3
Weaving segment length, L_S	475ft
Freeway free-flow speed, FFS	45 mph
Segment type	C-D Roadway/ Multilane Highways
Freeway minimum speed, S_{MIN}	15
Freeway maximum capacity, C_{IFL}	2250
Terrain type	Level

Conversions to pc/h Under Base Conditions

	V (veh/h)	PHF	Truck (%)	RV (%)	E_T	E_R	f_{HV}	f_p	v (pc/h)
V_{FF}	1179	0.90	8	0	1.5	1.2	0.962	1.00	1362
V_{RF}	853	0.90	11	0	1.5	1.2	0.948	1.00	1000
V_{FR}	452	0.90	8	0	1.5	1.2	0.962	1.00	522
V_{RR}	0	0.90	0	0	1.5	1.2	1.000	1.00	0
V_{NW}	1362							V =	2884
V_W	1522								
VR	0.528								

Configuration Characteristics

Minimum maneuver lanes, N_{WL}	2 lc	Minimum weaving lane changes, LC_{MIN}	1522 lc/h
Interchange density, ID	0.2 int/mi	Weaving lane changes, LC_W	1576 lc/h
Minimum RF lane changes, LC_{RF}	1 lc/pc	Non-weaving lane changes, LC_{NW}	0 lc/h
Minimum FR lane changes, LC_{FR}	1 lc/pc	Total lane changes, LC_{ALL}	1576 lc/h
Minimum RR lane changes, LC_{RR}	lc/pc	Non-weaving vehicle index, I_{NW}	13

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment flow rate, v	2884 pc/h	Weaving intensity factor, W	0.582
Weaving segment capacity, c_w	4373 veh/h	Weaving segment speed, S	31.7 mph
Weaving segment v/c ratio	0.634	Average weaving speed, S_W	34.0 mph
Weaving segment density, D	30.4 pc/mi/ln	Average non-weaving speed, S_{NW}	29.4 mph
Level of Service, LOS	C	Maximum weaving length, L_{MAX}	8152 ft

Notes

a. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments".
b. For volumes that exceed the weaving segment capacity, the level of service is "F".

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RAMP ADD OR DROP LANE ANALYSIS (MAINLINE <55 MPH)

ATKINS

General Information

Date Performed:	7/25/2014	Freeway/Direction	Cosgrove SB
Analysis Year	2038 No Action	Junction	From I-26 EB
Analysis Time Period:	AM Peak	Segment ID	7060
Project Description:	Navy Base ICTF		

Inputs

	Mainline Upstream Ramp	Mainline Downstream Ramp	Ramp
Number of Lanes, N	2	3	1
Free-Flow Speed, FFS (mph)	45	45	45
Volume, V (veh/h)	894	1,745	851
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	12%	12%	13%
%RVs, P_R	0%	0%	0%

Performance Measures

	Upstream of Off-Ramp	Downstream of Off-Ramp	Off-Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.94	0.94	0.94
Demand Flow Rate, v_p (pc/h/ln)	526	685	1,007
Capacity Flow Rate, c (pc/h/ln)	2,100	2,100	2,100
v/c ratio	0.25	0.33	0.48
Density, D_{MD} (pc/mi/ln)	9.2	12.0	17.6
LOS	A	B	B

Formulas and Reference Material

$$f_{HV} = \frac{1}{1+P_T(E_T-1)+P_R(E_R-1)}$$ HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P}$$ HCM 2010, Equation 11-2

$$D_{MD} = \frac{0.0175*v_f}{N}$$ HCM 2010, Equation 13-26

Ramp Roadways Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

Diverge LOS Thresholds

LOS	Density (pc/mi/ln)
A	≤10
B	>10-20
C	>20-28
D	>28-35
E	>35
F	v/c > 1

Source: HCM 2010, Exhibit 13-2

RAMP ADD OR DROP LANE ANALYSIS (MAINLINE <55 MPH)

ATKINS

General Information

Date Performed:	7/25/2014	Freeway/Direction	Cosgrove SB
Analysis Year	2038 No Action	Junction	From I-26 EB
Analysis Time Period:	PM Peak	Segment ID	7060
Project Description:	Navy Base ICTF		

Inputs

	Mainline Upstream Ramp	Mainline Downstream Ramp	Ramp
Number of Lanes, N	2	3	1
Free-Flow Speed, FFS (mph)	45	45	45
Volume, V (veh/h)	2,032	3,254	1,222
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	10%	10%	8%
%RVs, P_R	0%	0%	0%

Performance Measures

	Upstream of Off-Ramp	Downstream of Off-Ramp	Off-Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.95	0.95	0.96
Demand Flow Rate, v_p (pc/h/ln)	1,185	1,265	1,412
Capacity Flow Rate, c (pc/h/ln)	2,100	2,100	2,100
v/c ratio	0.56	0.60	0.67
Density, D_{MD} (pc/mi/ln)	20.7	22.1	24.7
LOS	C	C	C

Formulas and Reference Material

$$f_{HV} = \frac{1}{1+P_T(E_T-1)+P_R(E_R-1)}$$ HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P}$$ HCM 2010, Equation 11-2

$$D_{MD} = \frac{0.0175*v_f}{N}$$ HCM 2010, Equation 13-26

Ramp Roadways Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

Diverge LOS Thresholds

LOS	Density (pc/mi/ln)
A	≤10
B	>10-20
C	>20-28
D	>28-35
E	>35
F	v/c > 1

Source: HCM 2010, Exhibit 13-2

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	Montague NB
Agency or Company	Atkins	Junction	8010 - Off to I-26 EB
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2038 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Number of Lanes, N	2	Downstream Adj Ramp	
☐ Yes	☐ On	Acceleration Lane Length, L_A		☐ Yes	☐ On
☑ No	☐ Off	Deceleration Lane Length L_D	350	☑ No	☐ Off
L_{up} =	ft	Freeway Volume, V_F	2317	L_{down} =	ft
V_u =	veh/h	Ramp Volume, V_R	719	V_D =	veh/h
		Freeway Free-Flow Speed, S_{FF}	55.0		
		Ramp Free-Flow Speed, S_{FR}	45.0		

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	2317	0.90	Level	10	0	0.952	1.00	2703
Ramp	719	0.90	Level	8	0	0.962	1.00	831
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 1.000 using Equation (Exhibit 13-7)

V_{12} = 2703 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	2703	Exhibit 13-8	4500	No
$V_{FO} = V_F - V_R$	1872	Exhibit 13-8	4500	No
V_R	831	Exhibit 13-10	2100	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	2703	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = 24.3 (pc/mi/ln)

LOS = C (Exhibit 13-2)

Speed Determination

D_s = 0.373 (Exhibit 13-12)

S_R= 50.2 mph (Exhibit 13-12)

S_0= N/A mph (Exhibit 13-12)

S = 50.2 mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	Montague NB
Agency or Company	Atkins	Junction	8010 - Off to I-26 EB
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2038 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Number of Lanes, N	2	Downstream Adj Ramp	
☐ Yes	☐ On	Acceleration Lane Length, L_A		☐ Yes	☐ On
☑ No	☐ Off	Deceleration Lane Length L_D	350	☑ No	☐ Off
L_{up} =	ft	Freeway Volume, V_F	2576	L_{down} =	ft
V_u =	veh/h	Ramp Volume, V_R	779	V_D =	veh/h
		Freeway Free-Flow Speed, S_{FF}	55.0		
		Ramp Free-Flow Speed, S_{FR}	45.0		

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	2576	0.90	Level	8	0	0.962	1.00	2977
Ramp	779	0.90	Level	6	0	0.971	1.00	892
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 1.000 using Equation (Exhibit 13-7)

V_{12} = 2977 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	2977	Exhibit 13-8	4500	No
$V_{FO} = V_F - V_R$	2085	Exhibit 13-8	4500	No
V_R	892	Exhibit 13-10	2100	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	2977	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = 26.7 (pc/mi/ln)

LOS = C (Exhibit 13-2)

Speed Determination

D_s = 0.378 (Exhibit 13-12)

S_R= 50.1 mph (Exhibit 13-12)

S_0= N/A mph (Exhibit 13-12)

S = 50.1 mph (Exhibit 13-13)

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RAMP ADD OR DROP LANE ANALYSIS (MAINLINE <55 MPH)

ATKINS

General Information

Date Performed:	7/25/2014	Freeway/Direction	Montague NB
Analysis Year	2038 No Action	Junction	From I-26 EB
Analysis Time Period:	AM Peak	Segment ID	8020
Project Description:	Navy Base ICTF		

Inputs

	Mainline Upstream Ramp	Mainline Downstream Ramp	Ramp
Number of Lanes, N	2	3	1
Free-Flow Speed, FFS (mph)	45	45	25
Volume, V (veh/h)	1,598	2,115	517
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	10%	8%	6%
%RVs, P_R	0%	0%	0%

Performance Measures

	Upstream of Off-Ramp	Downstream of Off-Ramp	Off-Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.95	0.96	0.97
Demand Flow Rate, v_p (pc/h/ln)	932	815	592
Capacity Flow Rate, c (pc/h/ln)	2,100	2,100	1,900
v/c ratio	0.44	0.39	0.31
Density, D_{MD} (pc/mi/ln)	16.3	14.3	10.4
LOS	B	B	B

Formulas and Reference Material

$$f_{HV} = \frac{1}{1+P_T(E_T-1)+P_R(E_R-1)}$$ HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P}$$ HCM 2010, Equation 11-2

$$D_{MD} = \frac{0.0175*v_f}{N}$$ HCM 2010, Equation 13-26

Ramp Roadways Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

Diverge LOS Thresholds

LOS	Density (pc/mi/ln)
A	≤10
B	>10-20
C	>20-28
D	>28-35
E	>35
F	v/c > 1

Source: HCM 2010, Exhibit 13-2

RAMP ADD OR DROP LANE ANALYSIS (MAINLINE <55 MPH)

ATKINS

General Information

Date Performed:	7/25/2014	Freeway/Direction	Montague NB
Analysis Year	2038 No Action	Junction	From I-26 EB
Analysis Time Period:	PM Peak	Segment ID	8020
Project Description:	Navy Base ICTF		

Inputs

	Mainline Upstream Ramp	Mainline Downstream Ramp	Ramp
Number of Lanes, N	2	3	1
Free-Flow Speed, FFS (mph)	45	45	25
Volume, V (veh/h)	1,797	2,088	291
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	8%	6%	9%
%RVs, P_R	0%	0%	0%

Performance Measures

	Upstream of Off-Ramp	Downstream of Off-Ramp	Off-Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.96	0.97	0.96
Demand Flow Rate, v_p (pc/h/ln)	1,038	797	338
Capacity Flow Rate, c (pc/h/ln)	2,100	2,100	1,900
v/c ratio	0.49	0.38	0.18
Density, D_{MD} (pc/mi/ln)	18.2	13.9	5.9
LOS	B	B	A

Formulas and Reference Material

$$f_{HV} = \frac{1}{1+P_T(E_T-1)+P_R(E_R-1)}$$ HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P}$$ HCM 2010, Equation 11-2

$$D_{MD} = \frac{0.0175*v_f}{N}$$ HCM 2010, Equation 13-26

Ramp Roadways Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

Diverge LOS Thresholds

LOS	Density (pc/mi/ln)
A	≤10
B	>10-20
C	>20-28
D	>28-35
E	>35
F	v/c > 1

Source: HCM 2010, Exhibit 13-2

RAMP ADD OR DROP LANE ANALYSIS (MAINLINE <55 MPH)

ATKINS

General Information

Date Performed:	7/25/2014	Freeway/Direction	Montague SB
Analysis Year	2038 No Action	Junction	Off to I-26 EB
Analysis Time Period:	AM Peak	Segment ID	8030
Project Description:	Navy Base ICTF		

Inputs

	Mainline Upstream Ramp	Mainline Downstream Ramp	Ramp
Number of Lanes, N	3	2	1
Free-Flow Speed, FFS (mph)	45	45	25
Volume, V (veh/h)	1,992	1,539	453
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	8%	10%	15%
%RVs, P_R	0%	0%	0%

Performance Measures

	Upstream of Off-Ramp	Downstream of Off-Ramp	Off-Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.96	0.95	0.93
Demand Flow Rate, v_p (pc/h/ln)	767	898	541
Capacity Flow Rate, c (pc/h/ln)	2,100	2,100	1,900
v/c ratio	0.37	0.43	0.28
Density, D_{MD} (pc/mi/ln)	13.4	15.7	9.5
LOS	B	B	A

Formulas and Reference Material

$$f_{HV} = \frac{1}{1+P_T(E_T-1)+P_R(E_R-1)}$$ HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P}$$ HCM 2010, Equation 11-2

$$D_{MD} = \frac{0.0175*v_f}{N}$$ HCM 2010, Equation 13-26

Ramp Roadways Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

Diverge LOS Thresholds

LOS	Density (pc/mi/ln)
A	≤10
B	>10-20
C	>20-28
D	>28-35
E	>35
F	v/c > 1

Source: HCM 2010, Exhibit 13-2

RAMP ADD OR DROP LANE ANALYSIS (MAINLINE <55 MPH)

ATKINS

General Information

Date Performed:	7/25/2014	Freeway/Direction	Montague SB
Analysis Year	2038 No Action	Junction	Off to I-26 EB
Analysis Time Period:	PM Peak	Segment ID	8030
Project Description:	Navy Base ICTF		

Inputs

	Mainline Upstream Ramp	Mainline Downstream Ramp	Ramp
Number of Lanes, N	3	2	1
Free-Flow Speed, FFS (mph)	45	45	25
Volume, V (veh/h)	2,421	1,848	573
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	6%	8%	10%
%RVs, P_R	0%	0%	0%

Performance Measures

	Upstream of Off-Ramp	Downstream of Off-Ramp	Off-Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.97	0.96	0.95
Demand Flow Rate, v_p (pc/h/ln)	924	1,068	669
Capacity Flow Rate, c (pc/h/ln)	2,100	2,100	1,900
v/c ratio	0.44	0.51	0.35
Density, D_{MD} (pc/mi/ln)	16.2	18.7	11.7
LOS	B	B	B

Formulas and Reference Material

$$f_{HV} = \frac{1}{1+P_T(E_T-1)+P_R(E_R-1)}$$ HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P}$$ HCM 2010, Equation 11-2

$$D_{MD} = \frac{0.0175*v_f}{N}$$ HCM 2010, Equation 13-26

Ramp Roadways Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

Diverge LOS Thresholds

LOS	Density (pc/mi/ln)
A	≤10
B	>10-20
C	>20-28
D	>28-35
E	>35
F	v/c > 1

Source: HCM 2010, Exhibit 13-2

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	Montague SB
Agency or Company	Atkins	Junction	8040 - On from I-26 EB
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2038 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Freeway Number of Lanes, N: 2	☐ Yes ☐ On
☑ No ☐ Off	Ramp Number of Lanes, N: 1	☑ No ☐ Off
L_{up} = ft	Acceleration Lane Length, L_A: 550	L_{down} = ft
V_u = veh/h	Deceleration Lane Length L_D:	V_D = veh/h
	Freeway Volume, V_F: 1539	
	Ramp Volume, V_R: 492	
	Freeway Free-Flow Speed, S_{FF}: 55.0	
	Ramp Free-Flow Speed, S_{FR}: 45.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	1539	0.90	Level	10	0	0.952	1.00	1796
Ramp	492	0.90	Level	15	0	0.930	1.00	588
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 1.000 using Equation (Exhibit 13-6)

V_{12} = 1796 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	2384	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	2384	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = 20.4 (pc/mi/ln)

LOS = C (Exhibit 13-2)

Speed Determination

M_S = 0.314 (Exibit 13-11)

S_R= 50.9 mph (Exhibit 13-11)

S_0= N/A mph (Exhibit 13-11)

S = 50.9 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	Montague SB
Agency or Company	Atkins	Junction	8040 - On from I-26 EB
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2038 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Freeway Number of Lanes, N: 2	☐ Yes ☐ On
☑ No ☐ Off	Ramp Number of Lanes, N: 1	☑ No ☐ Off
L_{up} = ft	Acceleration Lane Length, L_A: 550	L_{down} = ft
V_u = veh/h	Deceleration Lane Length L_D:	V_D = veh/h
	Freeway Volume, V_F: 1848	
	Ramp Volume, V_R: 296	
	Freeway Free-Flow Speed, S_{FF}: 55.0	
	Ramp Free-Flow Speed, S_{FR}: 45.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	1848	0.90	Level	8	0	0.962	1.00	2135
Ramp	296	0.90	Level	8	0	0.962	1.00	342
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 1.000 using Equation (Exhibit 13-6)

V_{12} = 2135 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	2477	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	2477	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = 21.2 (pc/mi/ln)

LOS = C (Exhibit 13-2)

Speed Determination

M_S = 0.318 (Exibit 13-11)

S_R= 50.9 mph (Exhibit 13-11)

S_0= N/A mph (Exhibit 13-11)

S = 50.9 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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RAMP ADD OR DROP LANE ANALYSIS (MAINLINE <55 MPH)

ATKINS

General Information

Date Performed:	7/25/2014	Freeway/Direction	PAR NB
Analysis Year	2038 No Action	Junction	Merge from 26 EB & WB
Analysis Time Period:	AM Peak	Segment ID	9010
Project Description:	Navy Base ICTF		

Inputs

	Mainline Upstream Ramp	Mainline Downstream Ramp	Ramp
Number of Lanes, N	1	2	1
Free-Flow Speed, FFS (mph)	55	55	55
Volume, V (veh/h)	337	922	585
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	43%	43%	43%
%RVs, P_R	0%	0%	0%

Performance Measures

	Upstream of Off-Ramp	Downstream of Off-Ramp	Off-Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.82	0.82	0.82
Demand Flow Rate, v_p (pc/h/ln)	455	622	790
Capacity Flow Rate, c (pc/h/ln)	2,200	2,200	2,200
v/c ratio	0.21	0.28	0.36
Density, D_{MD} (pc/mi/ln)	8.0	10.9	13.8
LOS	A	B	B

Formulas and Reference Material

$$f_{HV} = \frac{1}{1+P_T(E_T-1)+P_R(E_R-1)}$$ HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P}$$ HCM 2010, Equation 11-2

$$D_{MD} = \frac{0.0175*v_f}{N}$$ HCM 2010, Equation 13-26

Ramp Roadways Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

Diverge LOS Thresholds

LOS	Density (pc/mi/ln)
A	≤10
B	>10-20
C	>20-28
D	>28-35
E	>35
F	v/c > 1

Source: HCM 2010, Exhibit 13-2

RAMP ADD OR DROP LANE ANALYSIS (MAINLINE <55 MPH)

ATKINS

General Information

Date Performed:	7/25/2014	Freeway/Direction	PAR NB
Analysis Year	2038 No Action	Junction	Merge from 26 EB & WB
Analysis Time Period:	PM Peak	Segment ID	9010
Project Description:	Navy Base ICTF		

Inputs

	Mainline Upstream Ramp	Mainline Downstream Ramp	Ramp
Number of Lanes, N	1	2	1
Free-Flow Speed, FFS (mph)	55	55	55
Volume, V (veh/h)	118	413	295
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	38%	38%	38%
%RVs, P_R	0%	0%	0%

Performance Measures

	Upstream of Off-Ramp	Downstream of Off-Ramp	Off-Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.84	0.84	0.84
Demand Flow Rate, v_p (pc/h/ln)	156	273	390
Capacity Flow Rate, c (pc/h/ln)	2,200	2,200	2,200
v/c ratio	0.07	0.12	0.18
Density, D_{MD} (pc/mi/ln)	2.7	4.8	6.8
LOS	A	A	A

Formulas and Reference Material

$$f_{HV} = \frac{1}{1+P_T(E_T-1)+P_R(E_R-1)}$$ HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P}$$ HCM 2010, Equation 11-2

$$D_{MD} = \frac{0.0175*v_f}{N}$$ HCM 2010, Equation 13-26

Ramp Roadways Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

Diverge LOS Thresholds

LOS	Density (pc/mi/ln)
A	≤10
B	>10-20
C	>20-28
D	>28-35
E	>35
F	v/c > 1

Source: HCM 2010, Exhibit 13-2

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	PAR NB
Agency or Company	Atkins	Junction	9020 - Off to Local Access Rd
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2038 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Freeway Number of Lanes, N	2	Downstream Adj Ramp	
☐ Yes	☐ On	Ramp Number of Lanes, N	1	☐ Yes	☐ On
☑ No	☐ Off	Acceleration Lane Length, L_A		☑ No	☐ Off
L_{up} =	ft	Deceleration Lane Length L_D	950	L_{down} =	ft
V_u =	veh/h	Freeway Volume, V_F	922	V_D =	veh/h
		Ramp Volume, V_R	229		
		Freeway Free-Flow Speed, S_{FF}	55.0		
		Ramp Free-Flow Speed, S_{FR}	45.0		

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	922	0.90	Level	43	0	0.823	1.00	1245
Ramp	229	0.90	Level	2	0	0.990	1.00	257
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 1.000 using Equation (Exhibit 13-7)

V_{12} = 1245 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	1245	Exhibit 13-8	4500	No
$V_{FO} = V_F - V_R$	988	Exhibit 13-8	4500	No
V_R	257	Exhibit 13-10	2100	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	1245	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = 6.4 (pc/mi/ln)

LOS = A (Exhibit 13-2)

Speed Determination

D_s = 0.321 (Exhibit 13-12)

S_R= 50.8 mph (Exhibit 13-12)

S_0= N/A mph (Exhibit 13-12)

S = 50.8 mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	PAR NB
Agency or Company	Atkins	Junction	9020 - Off to Local Access Rd
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2038 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp
☐ Yes ☐ On
☑ No ☐ Off
L_{up} = ft
V_u = veh/h

Freeway Number of Lanes, N	2
Ramp Number of Lanes, N	1
Acceleration Lane Length, L_A	
Deceleration Lane Length L_D	950
Freeway Volume, V_F	413
Ramp Volume, V_R	136
Freeway Free-Flow Speed, S_{FF}	55.0
Ramp Free-Flow Speed, S_{FR}	45.0

Downstream Adj Ramp
☐ Yes ☐ On
☑ No ☐ Off
L_{down} = ft
V_D = veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	413	0.90	Level	38	0	0.840	1.00	546
Ramp	136	0.90	Level	2	0	0.990	1.00	153
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)
P_{FM} = using Equation (Exhibit 13-6)
V_{12} = pc/h
V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)
Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No
Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No
If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = (pc/mi/ln)
LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)
S_R= mph (Exhibit 13-11)
S_0= mph (Exhibit 13-11)
S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)
P_{FD} = 1.000 using Equation (Exhibit 13-7)
V_{12} = 546 pc/h
V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)
Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No
Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No
If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	546	Exhibit 13-8	4500	No
$V_{FO} = V_F - V_R$	393	Exhibit 13-8	4500	No
V_R	153	Exhibit 13-10	2100	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	546	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = 0.4 (pc/mi/ln)
LOS = A (Exhibit 13-2)

Speed Determination

D_s = 0.312 (Exhibit 13-12)
S_R= 50.9 mph (Exhibit 13-12)
S_0= N/A mph (Exhibit 13-12)
S = 50.9 mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	PAR SB
Agency or Company	Atkins	Junction	9030 - On from Local Access Rd
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2038 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Number of Lanes, N: 2	☐ Yes ☐ On
☑ No ☐ Off	Acceleration Lane Length, L_A: 1000	☑ No ☐ Off
L_{up} = ft	Deceleration Lane Length L_D:	L_{down} = ft
V_u = veh/h	Freeway Volume, V_F: 279	V_D = veh/h
	Ramp Volume, V_R: 125	
	Freeway Free-Flow Speed, S_{FF}: 55.0	
	Ramp Free-Flow Speed, S_{FR}: 45.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	279	0.90	Level	58	0	0.775	1.00	400
Ramp	125	0.90	Level	2	0	0.990	1.00	140
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 1.000 using Equation (Exhibit 13-6)

V_{12} = 400 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	540	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	540	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = 3.4 (pc/mi/ln)

LOS = A (Exhibit 13-2)

Speed Determination

M_S = 0.238 (Exibit 13-11)

S_R= 51.9 mph (Exhibit 13-11)

S_0= N/A mph (Exhibit 13-11)

S = 51.9 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	PAR SB
Agency or Company	Atkins	Junction	9030 - On from Local Access Rd
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2038 No Action

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Number of Lanes, N: 2	☐ Yes ☐ On
☑ No ☐ Off	Acceleration Lane Length, L_A: 1000	☑ No ☐ Off
L_{up} = ft	Deceleration Lane Length L_D:	L_{down} = ft
V_u = veh/h	Freeway Volume, V_F: 646	V_D = veh/h
	Ramp Volume, V_R: 225	
	Freeway Free-Flow Speed, S_{FF}: 55.0	
	Ramp Free-Flow Speed, S_{FR}: 45.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	646	0.90	Level	52	0	0.794	1.00	904
Ramp	225	0.90	Level	2	0	0.990	1.00	253
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 1.000 using Equation (Exhibit 13-6)

V_{12} = 904 pc/h

V_3 or V_{av34} 0 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	1157	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	1157	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = 8.1 (pc/mi/ln)

LOS = A (Exhibit 13-2)

Speed Determination

M_S = 0.243 (Exibit 13-11)

S_R= 51.8 mph (Exhibit 13-11)

S_0= N/A mph (Exhibit 13-11)

S = 51.8 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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RAMP ADD OR DROP LANE ANALYSIS (MAINLINE <55 MPH)

ATKINS

General Information

Date Performed:	7/25/2014	Freeway/Direction	PAR SB
Analysis Year	2038 No Action	Junction	Split to 26 EB & WB
Analysis Time Period:	AM Peak	Segment ID	9040
Project Description:	Navy Base ICTF		

Inputs

	Mainline Upstream Ramp	Mainline Downstream Ramp	Ramp
Number of Lanes, N	2	1	1
Free-Flow Speed, FFS (mph)	55	55	55
Volume, V (veh/h)	404	294	110
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	43%	43%	43%
%RVs, P_R	0%	0%	0%

Performance Measures

	Upstream of Off-Ramp	Downstream of Off-Ramp	Off-Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.82	0.82	0.82
Demand Flow Rate, v_p (pc/h/ln)	273	397	149
Capacity Flow Rate, c (pc/h/ln)	2,200	2,200	2,200
v/c ratio	0.12	0.18	0.07
Density, D_{MD} (pc/mi/ln)	4.8	6.9	2.6
LOS	A	A	A

Formulas and Reference Material

$$f_{HV} = \frac{1}{1+P_T(E_T-1)+P_R(E_R-1)}$$ HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P}$$ HCM 2010, Equation 11-2

$$D_{MD} = \frac{0.0175*v_f}{N}$$ HCM 2010, Equation 13-26

Ramp Roadways Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

Diverge LOS Thresholds

LOS	Density (pc/mi/ln)
A	≤10
B	>10-20
C	>20-28
D	>28-35
E	>35
F	v/c > 1

Source: HCM 2010, Exhibit 13-2

RAMP ADD OR DROP LANE ANALYSIS (MAINLINE <55 MPH)

ATKINS

General Information

Date Performed:	7/25/2014	Freeway/Direction	PAR SB
Analysis Year	2038 No Action	Junction	Split to 26 EB & WB
Analysis Time Period:	PM Peak	Segment ID	9040
Project Description:	Navy Base ICTF		

Inputs

	Mainline Upstream Ramp	Mainline Downstream Ramp	Ramp
Number of Lanes, N	2	1	1
Free-Flow Speed, FFS (mph)	55	55	55
Volume, V (veh/h)	871	571	300
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	38%	38%	38%
%RVs, P_R	0%	0%	0%

Performance Measures

	Upstream of Off-Ramp	Downstream of Off-Ramp	Off-Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.84	0.84	0.84
Demand Flow Rate, v_p (pc/h/ln)	576	755	397
Capacity Flow Rate, c (pc/h/ln)	2,200	2,200	2,200
v/c ratio	0.26	0.34	0.18
Density, D_{MD} (pc/mi/ln)	10.1	13.2	6.9
LOS	B	B	A

Formulas and Reference Material

$$f_{HV} = \frac{1}{1+P_T(E_T-1)+P_R(E_R-1)}$$ HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P}$$ HCM 2010, Equation 11-2

$$D_{MD} = \frac{0.0175*v_f}{N}$$ HCM 2010, Equation 13-26

Ramp Roadways Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

Diverge LOS Thresholds

LOS	Density (pc/mi/ln)
A	≤10
B	>10-20
C	>20-28
D	>28-35
E	>35
F	v/c > 1

Source: HCM 2010, Exhibit 13-2

Arterial Level of Service: NB #1

Cross Street	Arterial Class	Flow Speed	Running Time	Signal Delay	Travel Time (s)	Dist (mi)	Arterial Speed	Arterial LOS
Viaduct Rd	II	40	28.5	12.6	41.1	0.26	22.7	C
Carolina Ave	II	35	43.3	4.3	47.6	0.41	31.2	B
Reynolds Ave	II	35	44.7	8.3	53.0	0.43	29.2	B
Cosgrove Ave	II	40	29.3	17.1	46.4	0.29	22.3	C
McMillan Ave	II	40	16.8	66.7	83.5	0.15	6.3	F
Total	II		162.6	109.0	271.6	1.53	20.3	D

Arterial Level of Service: SB #1

Cross Street	Arterial Class	Flow Speed	Running Time	Signal Delay	Travel Time (s)	Dist (mi)	Arterial Speed	Arterial LOS
Cosgrove Ave	II	40	16.8	49.7	66.5	0.15	7.9	F
Reynolds Ave	II	40	29.3	24.7	54.0	0.29	19.1	D
Carolina Ave	II	35	44.7	7.7	52.4	0.43	29.5	B
Burton Ln	II	40	39.6	13.1	52.7	0.41	28.2	B
Stromboli Ave	II	40	28.5	8.9	37.4	0.26	24.9	C
Total	II		158.9	104.1	263.0	1.53	21.0	D

Arterial Level of Service: NB #1

Cross Street	Arterial Class	Flow Speed	Running Time	Signal Delay	Travel Time (s)	Dist (mi)	Arterial Speed	Arterial LOS
Viaduct Rd	II	40	28.5	26.5	55.0	0.26	16.9	E
Carolina Ave	II	35	43.3	7.7	51.0	0.41	29.1	B
Reynolds Ave	II	35	44.7	20.4	65.1	0.43	23.8	C
Cosgrove Ave	II	40	29.3	84.4	113.7	0.29	9.1	F
McMillan Ave	II	40	16.8	63.3	80.1	0.15	6.6	F
Total	II		162.6	202.3	364.9	1.53	15.1	E

Arterial Level of Service: SB #1

Cross Street	Arterial Class	Flow Speed	Running Time	Signal Delay	Travel Time (s)	Dist (mi)	Arterial Speed	Arterial LOS
Cosgrove Ave	II	40	16.8	17.9	34.7	0.15	15.1	E
Reynolds Ave	II	40	29.3	9.9	39.2	0.29	26.4	C
Carolina Ave	II	35	44.7	4.0	48.7	0.43	31.8	B
Burton Ln	II	40	39.6	16.4	56.0	0.41	26.5	C
Stromboli Ave	II	40	28.5	10.1	38.6	0.26	24.1	C
Total	II		158.9	58.3	217.2	1.53	25.4	C

Arterial Level of Service: NB #2

Cross Street	Arterial Class	Flow Speed	Running Time	Signal Delay	Travel Time (s)	Dist (mi)	Arterial Speed	Arterial LOS
Burton Ln	III	34	35.4	10.5	45.9	0.29	23.1	C
Reynolds Ave	III	35	50.6	11.0	61.6	0.42	24.6	B
Cosgrove Ave	III	35	27.9	18.7	46.6	0.23	17.9	D
Dorchester Rd	III	35	18.7	2.9	21.6	0.15	24.4	B
McMillan Ave	III	35	24.5	23.4	47.9	0.20	15.3	D
Total	III		157.1	66.5	223.6	1.30	20.9	C

Arterial Level of Service: SB #2

Cross Street	Arterial Class	Flow Speed	Running Time	Signal Delay	Travel Time (s)	Dist (mi)	Arterial Speed	Arterial LOS
Dorchester Rd	II	35	25.5	5.8	31.3	0.20	23.5	C
Cosgrove Ave	II	35	18.3	30.9	49.2	0.15	10.7	F
Reynolds Ave	II	35	27.6	6.1	33.7	0.23	24.8	C
Burton Ln	II	35	44.6	15.1	59.7	0.43	25.9	C
Stromboli Ave	II	37	32.4	2.1	34.5	0.29	30.8	B
Total	II		148.4	60.0	208.4	1.31	22.6	C

Arterial Level of Service: NB #2

Cross Street	Arterial Class	Flow Speed	Running Time	Signal Delay	Travel Time (s)	Dist (mi)	Arterial Speed	Arterial LOS
Burton Ln	III	34	35.4	14.3	49.7	0.29	21.3	C
Reynolds Ave	III	35	50.6	15.9	66.5	0.42	22.8	C
Cosgrove Ave	III	35	27.9	34.9	62.8	0.23	13.3	E
Dorchester Rd	III	35	18.7	4.0	22.7	0.15	23.2	C
McMillan Ave	III	35	24.5	19.6	44.1	0.20	16.7	D
Total	III		157.1	88.7	245.8	1.30	19.0	C

Arterial Level of Service: SB #2

Cross Street	Arterial Class	Flow Speed	Running Time	Signal Delay	Travel Time (s)	Dist (mi)	Arterial Speed	Arterial LOS
Dorchester Rd	II	35	25.5	5.6	31.1	0.20	23.6	C
Cosgrove Ave	II	35	18.3	50.6	68.9	0.15	7.6	F
Reynolds Ave	II	35	27.6	1.6	29.2	0.23	28.6	B
Burton Ln	II	35	44.6	11.9	56.5	0.43	27.3	C
Stromboli Ave	II	37	32.4	1.7	34.1	0.29	31.1	B
Total	II		148.4	71.4	219.8	1.31	21.4	D

Intersection: 10: Rivers Ave SB & I-526 WB Ramps

Movement	WB	WB	SB	SB	SB	SB
Directions Served	T	T	T	T	T	R
Maximum Queue (ft)	138	130	195	145	114	18
Average Queue (ft)	63	61	103	60	47	1
95th Queue (ft)	112	110	166	118	96	18
Link Distance (ft)	136	136	1224	1224	1224	
Upstream Blk Time (%)	0	0				
Queuing Penalty (veh)	0	0				
Storage Bay Dist (ft)						325
Storage Blk Time (%)						
Queuing Penalty (veh)						

Intersection: 11: Rivers Ave NB/Rivers Ave & I-526 WB Ramps

Movement
Directions Served
Maximum Queue (ft)
Average Queue (ft)
95th Queue (ft)
Link Distance (ft)
Upstream Blk Time (%)
Queuing Penalty (veh)
Storage Bay Dist (ft)
Storage Blk Time (%)
Queuing Penalty (veh)

Intersection: 20: Rivers Ave NB & I-526 EB Ramps

Movement	EB	EB	NB	NB	NB	NB
Directions Served	T	T	T	T	T	R
Maximum Queue (ft)	143	149	169	139	142	96
Average Queue (ft)	72	80	58	45	53	11
95th Queue (ft)	127	128	118	98	109	55
Link Distance (ft)	157	157	1619	1619	1619	
Upstream Blk Time (%)	0	0				
Queuing Penalty (veh)	0	0				
Storage Bay Dist (ft)						350
Storage Blk Time (%)						
Queuing Penalty (veh)						

Intersection: 21: Rivers Ave SB & I-526 EB Ramps

Movement
Directions Served
Maximum Queue (ft)
Average Queue (ft)
95th Queue (ft)
Link Distance (ft)
Upstream Blk Time (%)
Queuing Penalty (veh)
Storage Bay Dist (ft)
Storage Blk Time (%)
Queuing Penalty (veh)

Intersection: 30: Rivers Ave SB & Mall Dr

Movement	EB	EB	NB	SB	SB	SB	SB
Directions Served	T	R	L	T	T	T	R
Maximum Queue (ft)	213	112	129	317	303	282	219
Average Queue (ft)	112	28	44	146	133	107	73
95th Queue (ft)	187	72	96	265	249	218	152
Link Distance (ft)	1458		122	2788	2788	2788	
Upstream Blk Time (%)			1				
Queuing Penalty (veh)			0				
Storage Bay Dist (ft)		125					140
Storage Blk Time (%)	7					3	1
Queuing Penalty (veh)	4					13	3

Intersection: 31: Rivers Ave NB & Mall Dr Left

Movement
Directions Served
Maximum Queue (ft)
Average Queue (ft)
95th Queue (ft)
Link Distance (ft)
Upstream Blk Time (%)
Queuing Penalty (veh)
Storage Bay Dist (ft)
Storage Blk Time (%)
Queuing Penalty (veh)

Intersection: 32: Rivers Ave NB & Rivers Ave NB Left

Movement
Directions Served
Maximum Queue (ft)
Average Queue (ft)
95th Queue (ft)
Link Distance (ft)
Upstream Blk Time (%)
Queuing Penalty (veh)
Storage Bay Dist (ft)
Storage Blk Time (%)
Queuing Penalty (veh)

Intersection: 33: Rivers Ave SB

Movement	WB	SB	SB	SB
Directions Served	R	T	T	T
Maximum Queue (ft)	4	16	6	13
Average Queue (ft)	0	1	0	1
95th Queue (ft)	4	12	6	12
Link Distance (ft)	73	122	122	122
Upstream Blk Time (%)				
Queuing Penalty (veh)				
Storage Bay Dist (ft)				
Storage Blk Time (%)				
Queuing Penalty (veh)				

Intersection: 40: Rivers Ave NB & WB Montague Ramps

Movement	WB	WB	NB	NB	NB	SB
Directions Served	T	R	T	T	TR	L
Maximum Queue (ft)	74	184	107	125	152	154
Average Queue (ft)	21	83	20	24	36	90
95th Queue (ft)	57	144	72	87	105	153
Link Distance (ft)	470		346	346	346	76
Upstream Blk Time (%)						15
Queuing Penalty (veh)						21
Storage Bay Dist (ft)		380				
Storage Blk Time (%)						
Queuing Penalty (veh)						

Intersection: 41: Rivers Ave SB & WB Montague Ramps

Movement			
Directions Served			
Maximum Queue (ft)			
Average Queue (ft)			
95th Queue (ft)			
Link Distance (ft)			
Upstream Blk Time (%)			
Queuing Penalty (veh)			
Storage Bay Dist (ft)			
Storage Blk Time (%)			
Queuing Penalty (veh)			

Intersection: 42: Rivers Ave NB

Movement	EB	NB	
Directions Served	R	T	
Maximum Queue (ft)	118	6	
Average Queue (ft)	11	0	
95th Queue (ft)	58	6	
Link Distance (ft)	109	76	
Upstream Blk Time (%)	0		
Queuing Penalty (veh)	0		
Storage Bay Dist (ft)			
Storage Blk Time (%)			
Queuing Penalty (veh)			

Intersection: 43: Rivers Ave SB & Montague Ramp Left

Movement			
Directions Served			
Maximum Queue (ft)			
Average Queue (ft)			
95th Queue (ft)			
Link Distance (ft)			
Upstream Blk Time (%)			
Queuing Penalty (veh)			
Storage Bay Dist (ft)			
Storage Blk Time (%)			
Queuing Penalty (veh)			

Intersection: 50: Rivers Ave NB & Morningside Dr

Movement	WB	WB	NB	NB	NB	NB	SB
Directions Served	T	R	T	T	T	R	L
Maximum Queue (ft)	365	64	157	185	252	180	137
Average Queue (ft)	193	20	71	87	113	34	89
95th Queue (ft)	321	47	142	164	210	93	139
Link Distance (ft)	701		666	666	666		61
Upstream Blk Time (%)							40
Queuing Penalty (veh)							53
Storage Bay Dist (ft)		425				120	
Storage Blk Time (%)	0				12	0	
Queuing Penalty (veh)	0				12	0	

Intersection: 51: Rivers Ave SB & Morningside Dr

Movement	SB	SB
Directions Served	L	T
Maximum Queue (ft)	51	6
Average Queue (ft)	3	0
95th Queue (ft)	24	3
Link Distance (ft)	186	186
Upstream Blk Time (%)		
Queuing Penalty (veh)		
Storage Bay Dist (ft)		
Storage Blk Time (%)		
Queuing Penalty (veh)		

Intersection: 52: Rivers Ave NB

Movement	EB
Directions Served	R
Maximum Queue (ft)	126
Average Queue (ft)	26
95th Queue (ft)	89
Link Distance (ft)	60
Upstream Blk Time (%)	5
Queuing Penalty (veh)	7
Storage Bay Dist (ft)	
Storage Blk Time (%)	
Queuing Penalty (veh)	

Intersection: 53: Rivers Ave SB & Morningside Dr Left

Movement
Directions Served
Maximum Queue (ft)
Average Queue (ft)
95th Queue (ft)
Link Distance (ft)
Upstream Blk Time (%)
Queuing Penalty (veh)
Storage Bay Dist (ft)
Storage Blk Time (%)
Queuing Penalty (veh)

Intersection: 55: Rivers Ave/Rivers Ave SB & Rivers Ave NB

Movement	SB	SB	SB
Directions Served	T	T	T
Maximum Queue (ft)	60	61	67
Average Queue (ft)	2	6	7
95th Queue (ft)	58	33	37
Link Distance (ft)	560	560	560
Upstream Blk Time (%)	0		
Queuing Penalty (veh)	0		
Storage Bay Dist (ft)			
Storage Blk Time (%)			
Queuing Penalty (veh)			

Intersection: 60: Rivers Ave & Piggly Wiggly Dr

Movement	EB	EB	EB	NB	NB	NB	NB	SB	SB	SB	SB
Directions Served	L	L	R	L	T	T	T	T	T	T	R
Maximum Queue (ft)	138	217	104	139	96	116	151	129	166	133	71
Average Queue (ft)	20	93	6	51	24	31	56	37	66	48	28
95th Queue (ft)	84	171	53	110	69	86	124	100	141	115	64
Link Distance (ft)		468			2162	2162	2162	716	716	716	
Upstream Blk Time (%)											
Queuing Penalty (veh)											
Storage Bay Dist (ft)	75		50	125							425
Storage Blk Time (%)	0	34		1	0						
Queuing Penalty (veh)	0	30		2	0						

Intersection: 70: Rivers Ave & Meeting St/Durant Ave

Movement	EB	EB	WB	WB	WB	NB	NB	NB	SB	SB	SB	SB
Directions Served	L	TR	L	T	R	LT	T	TR	L	T	T	R
Maximum Queue (ft)	140	178	189	194	86	208	202	274	205	302	294	141
Average Queue (ft)	63	66	91	74	29	95	96	138	92	177	189	55
95th Queue (ft)	119	134	158	149	63	174	176	241	165	273	275	110
Link Distance (ft)		460		552		673	673			2162	2162	2162
Upstream Blk Time (%)												
Queuing Penalty (veh)												
Storage Bay Dist (ft)	50		125		150			300	725			
Storage Blk Time (%)	27	13	5	1				0				
Queuing Penalty (veh)	25	14	14	4				0				

Intersection: 80: Rivers Ave & Helm Ave

Movement	EB	WB	NB	NB	NB	SB	SB	SB	B212
Directions Served	LTR	LTR	L	T	TR	L	T	TR	T
Maximum Queue (ft)	70	160	41	216	243	49	266	280	70
Average Queue (ft)	23	61	7	84	108	10	123	134	3
95th Queue (ft)	52	122	27	177	200	33	239	245	72
Link Distance (ft)	737	713		3153	3153		2604	2604	673
Upstream Blk Time (%)									
Queuing Penalty (veh)									
Storage Bay Dist (ft)			225			200			
Storage Blk Time (%)				0			1		
Queuing Penalty (veh)				0			0		

Intersection: 90: Rivers Ave #2/Rivers Ave & McMillan Ave

Movement	EB	EB	WB	WB	NB	NB	NB	NB	SB	SB	SB	SB
Directions Served	LT	TR	LT	R	L	T	T	R	L	T	T	R
Maximum Queue (ft)	111	73	298	133	56	231	254	168	270	332	305	48
Average Queue (ft)	42	7	135	42	4	115	126	59	117	93	116	9
95th Queue (ft)	92	36	245	103	36	203	221	123	234	235	246	34
Link Distance (ft)	1091	1091	1517	1517		981	981			3153	3153	
Upstream Blk Time (%)												
Queuing Penalty (veh)												
Storage Bay Dist (ft)					200			200	200			200
Storage Blk Time (%)						1	1	0	4	1	2	
Queuing Penalty (veh)						0	4	0	17	3	1	

Intersection: 100: Rivers Ave #2 & Dorchester Rd

Movement	EB	EB	NB	NB	NB	SB	SB	SB
Directions Served	L	R	L	T	T	T	T	R
Maximum Queue (ft)	232	199	172	93	130	138	167	66
Average Queue (ft)	112	78	66	24	49	59	71	21
95th Queue (ft)	198	158	135	70	102	114	136	52
Link Distance (ft)	1350			658	658	981	981	
Upstream Blk Time (%)								
Queuing Penalty (veh)								
Storage Bay Dist (ft)		100	185					200
Storage Blk Time (%)	14	2	0				0	
Queuing Penalty (veh)	23	5	1				0	

Intersection: 110: Rivers Ave #2 & Cosgrove Ave

Movement	EB	EB	EB	WB	WB	WB	NB	NB	NB	SB	SB	SB
Directions Served	L	T	TR	L	T	TR	L	T	TR	L	T	T
Maximum Queue (ft)	379	437	427	84	229	252	162	169	178	129	285	270
Average Queue (ft)	204	224	237	32	127	151	65	62	78	46	143	125
95th Queue (ft)	339	388	396	72	195	222	127	128	146	100	242	220
Link Distance (ft)		3181	3181		1391	1391		1140	1140		658	658
Upstream Blk Time (%)												
Queuing Penalty (veh)												
Storage Bay Dist (ft)	450			165			200			200		
Storage Blk Time (%)	0	0			3		0	0		0	4	12
Queuing Penalty (veh)	1	0			1		0	0		0	3	35

Intersection: 110: Rivers Ave #2 & Cosgrove Ave

Movement	SB
Directions Served	R
Maximum Queue (ft)	212
Average Queue (ft)	75
95th Queue (ft)	169
Link Distance (ft)	
Upstream Blk Time (%)	
Queuing Penalty (veh)	
Storage Bay Dist (ft)	125
Storage Blk Time (%)	2
Queuing Penalty (veh)	5

Intersection: 120: Rivers Ave #2 & Reynolds Ave

Movement	EB	WB	NB	NB	NB	SB	SB	SB	SB
Directions Served	LTR	LTR	L	T	TR	L	T	T	R
Maximum Queue (ft)	237	265	59	157	148	129	234	192	92
Average Queue (ft)	114	119	17	65	64	44	97	66	12
95th Queue (ft)	205	224	48	130	128	98	190	147	51
Link Distance (ft)	666	1494		1257	1257		1140	1140	
Upstream Blk Time (%)									
Queuing Penalty (veh)									
Storage Bay Dist (ft)			200			200			50
Storage Blk Time (%)				0		0	1	11	0
Queuing Penalty (veh)				0		0	1	4	1

Intersection: 123: Bend

Movement	SB	SB
Directions Served	T	T
Maximum Queue (ft)	76	126
Average Queue (ft)	3	3
95th Queue (ft)	56	59
Link Distance (ft)	422	422
Upstream Blk Time (%)		0
Queuing Penalty (veh)		0
Storage Bay Dist (ft)		
Storage Blk Time (%)		
Queuing Penalty (veh)		

Intersection: 130: Rivers Ave/Rivers Ave #2 & Carner Ave #2

Movement	WB	NB	NB	SB	SB
Directions Served	R	T	TR	L	T
Maximum Queue (ft)	150	12	62	259	38
Average Queue (ft)	75	1	15	117	1
95th Queue (ft)	122	8	48	220	38
Link Distance (ft)	2094	773	773		1257
Upstream Blk Time (%)					
Queuing Penalty (veh)					
Storage Bay Dist (ft)				250	
Storage Blk Time (%)				1	
Queuing Penalty (veh)				2	

Intersection: 140: Carner Ave #2 & Burton Ln

Movement	EB	WB	WB	NB	NB	NB	SB	SB
Directions Served	LTR	LT	R	L	T	R	L	TR
Maximum Queue (ft)	121	97	55	49	142	66	140	228
Average Queue (ft)	58	40	17	11	65	9	57	102
95th Queue (ft)	102	81	43	36	120	42	112	187
Link Distance (ft)	572	1388			222			2094
Upstream Blk Time (%)								
Queuing Penalty (veh)								
Storage Bay Dist (ft)			190	120		50	170	
Storage Blk Time (%)					11	0	0	1
Queuing Penalty (veh)					3	0	0	2

Intersection: 150: Carner Ave/Carner Ave #2 & Stromboli Ave

Movement	WB	WB	WB	NB	NB	SB	SB	SB
Directions Served	L	L	R	T	TR	L	T	T
Maximum Queue (ft)	3	49	47	82	22	41	83	104
Average Queue (ft)	0	9	10	16	1	4	15	14
95th Queue (ft)	3	34	36	60	9	22	53	62
Link Distance (ft)		1754	1754	1034	1034		671	671
Upstream Blk Time (%)								
Queuing Penalty (veh)								
Storage Bay Dist (ft)	300					250		
Storage Blk Time (%)								
Queuing Penalty (veh)								

Intersection: 160: Spruill Ave & Montague Ave

Movement	EB	EB	WB	WB	NB	NB	SB	SB
Directions Served	L	TR	L	TR	L	TR	L	TR
Maximum Queue (ft)	27	244	90	96	134	155	41	140
Average Queue (ft)	2	125	43	36	59	74	12	58
95th Queue (ft)	14	215	77	79	113	130	37	110
Link Distance (ft)		450		1923		680		573
Upstream Blk Time (%)								
Queuing Penalty (veh)								
Storage Bay Dist (ft)	125		75		275		90	
Storage Blk Time (%)		7	2	1				3
Queuing Penalty (veh)		0	2	1				0

Intersection: 170: Spruill Ave #1/Spruill Ave & McMillan Ave

Movement	EB	EB	EB	WB	WB	WB	NB	NB	SB	SB	SB
Directions Served	L	T	TR	L	T	TR	L	TR	L	T	R
Maximum Queue (ft)	127	195	221	245	151	136	410	668	375	834	300
Average Queue (ft)	49	94	106	228	33	30	209	520	118	709	160
95th Queue (ft)	102	160	184	260	94	81	475	806	365	1001	386
Link Distance (ft)		1517	1517	220	220	220		652		774	
Upstream Blk Time (%)				70	1	0		6		39	
Queuing Penalty (veh)				109	1	0		48		0	
Storage Bay Dist (ft)	225						310		275		200
Storage Blk Time (%)		0					3	44		50	
Queuing Penalty (veh)		0					20	37		75	

Intersection: 180: Spruill Ave #1 & Cosgrove Ave

Movement	EB	EB	EB	WB	WB	WB	NB	NB	SB	SB	SB
Directions Served	L	T	TR	L	T	TR	L	TR	L	T	R
Maximum Queue (ft)	325	779	502	13	34	19	135	268	29	364	201
Average Queue (ft)	257	291	107	1	5	1	44	108	4	195	11
95th Queue (ft)	390	865	395	7	21	10	105	221	18	311	95
Link Distance (ft)		1391	1391		1117	1117		1405		652	
Upstream Blk Time (%)											
Queuing Penalty (veh)											
Storage Bay Dist (ft)	225			30			260		140		280
Storage Blk Time (%)	36			0	1			0		16	
Queuing Penalty (veh)	28			0	0			0		60	

Intersection: 190: Spruill Ave #1 & Reynolds Ave

Movement	EB	WB	WB	NB	NB	SB	SB
Directions Served	LTR	L	TR	L	TR	L	TR
Maximum Queue (ft)	264	36	74	177	220	105	380
Average Queue (ft)	100	4	25	61	89	5	187
95th Queue (ft)	202	22	61	125	183	54	348
Link Distance (ft)	1494		716		2143		1405
Upstream Blk Time (%)							
Queuing Penalty (veh)							
Storage Bay Dist (ft)		200		185		180	
Storage Blk Time (%)				0	1		7
Queuing Penalty (veh)				0	0		1

Intersection: 200: Spruill Ave #1 & Carolina Ave

Movement	WB	NB	NB	SB
Directions Served	L	T	R	T
Maximum Queue (ft)	85	184	74	282
Average Queue (ft)	37	67	4	107
95th Queue (ft)	72	149	41	232
Link Distance (ft)	573	2062		2143
Upstream Blk Time (%)				
Queuing Penalty (veh)				
Storage Bay Dist (ft)			50	
Storage Blk Time (%)		7		
Queuing Penalty (veh)		6		

Intersection: 210: Spruill Ave #1 & Burton Ln/Viaduct Rd

Movement	EB	EB	WB	WB	WB	NB	NB	SB	SB
Directions Served	LT	TR	L	T	R	L	TR	L	TR
Maximum Queue (ft)	109	126	91	92	98	64	263	244	366
Average Queue (ft)	42	51	31	29	39	13	123	112	110
95th Queue (ft)	92	104	73	69	78	55	232	214	277
Link Distance (ft)		1388		1596			1278		2062
Upstream Blk Time (%)									
Queuing Penalty (veh)									
Storage Bay Dist (ft)	250		340		250	150		170	
Storage Blk Time (%)							4	5	1
Queuing Penalty (veh)							1	28	2

Intersection: 220: Spruill Ave/Spruill Ave #1 & Stromboli Ave

Movement	EB	EB	EB	WB	WB	WB	NB	NB	SB	SB
Directions Served	L	T	TR	L	T	TR	L	TR	L	TR
Maximum Queue (ft)	56	45	61	47	16	47	38	242	84	233
Average Queue (ft)	11	4	12	13	1	15	6	122	32	96
95th Queue (ft)	39	23	42	38	9	36	25	218	69	195
Link Distance (ft)		1754	1754		1627	1627		518		1278
Upstream Blk Time (%)										
Queuing Penalty (veh)										
Storage Bay Dist (ft)	250			250			250		250	
Storage Blk Time (%)								0		0
Queuing Penalty (veh)								0		0

Intersection: 230: McMillan Ave & St Johns Ave

Movement	EB	EB	WB	WB	SB
Directions Served	LT	T	T	TR	LR
Maximum Queue (ft)	131	60	698	626	547
Average Queue (ft)	52	3	338	155	436
95th Queue (ft)	105	40	730	531	710
Link Distance (ft)	220	220	1999	1999	517
Upstream Blk Time (%)	0	0			71
Queuing Penalty (veh)	0	0			0
Storage Bay Dist (ft)					
Storage Blk Time (%)					
Queuing Penalty (veh)					

Intersection: 240: Noisette Blvd & McMillan Ave

Movement	EB	WB	WB	NB	SB	SB
Directions Served	LT	LT	TR	LTR	LT	R
Maximum Queue (ft)	93	25	2	42	84	96
Average Queue (ft)	25	2	0	16	39	55
95th Queue (ft)	66	13	2	42	74	82
Link Distance (ft)	1999	324	324	535	1291	1291
Upstream Blk Time (%)						
Queuing Penalty (veh)						
Storage Bay Dist (ft)						
Storage Blk Time (%)						
Queuing Penalty (veh)						

Intersection: 250: Hobson Ave & McMillan Ave

Movement	EB	EB	WB	NB	SB
Directions Served	LT	R	LTR	LT	LT
Maximum Queue (ft)	54	99	33	60	10
Average Queue (ft)	21	53	11	17	0
95th Queue (ft)	49	82	35	45	5
Link Distance (ft)	324	324	721	578	583
Upstream Blk Time (%)					
Queuing Penalty (veh)					
Storage Bay Dist (ft)					
Storage Blk Time (%)					
Queuing Penalty (veh)					

Intersection: 260: Noisette Blvd & Turnbull Ave

Movement	EB	WB	WB	NB	NB	SB
Directions Served	LTR	LT	R	LT	R	LTR
Maximum Queue (ft)	84	37	50	147	44	173
Average Queue (ft)	39	14	20	72	10	85
95th Queue (ft)	65	37	41	116	33	140
Link Distance (ft)	550	315		1291	1291	2516
Upstream Blk Time (%)						
Queuing Penalty (veh)						
Storage Bay Dist (ft)			75			
Storage Blk Time (%)		0	0			
Queuing Penalty (veh)		0	0			

Intersection: 270: Noisette Blvd & Avenue B

Movement	WB	SB
Directions Served	LR	LT
Maximum Queue (ft)	62	90
Average Queue (ft)	19	15
95th Queue (ft)	51	54
Link Distance (ft)	564	593
Upstream Blk Time (%)		
Queuing Penalty (veh)		
Storage Bay Dist (ft)		
Storage Blk Time (%)		
Queuing Penalty (veh)		

Intersection: 280: Virginia Ave & Avenue B

Movement	WB	NB	SB	SB
Directions Served	L	TR	L	T
Maximum Queue (ft)	77	48	178	15
Average Queue (ft)	23	6	73	1
95th Queue (ft)	56	26	138	11
Link Distance (ft)	593	466	1266	1266
Upstream Blk Time (%)				
Queuing Penalty (veh)				
Storage Bay Dist (ft)				
Storage Blk Time (%)	0			
Queuing Penalty (veh)	1			

Intersection: 290: Virginia Ave & Montague Ave

Movement	EB	NB	SB
Directions Served	LR	L	TR
Maximum Queue (ft)	142	64	9
Average Queue (ft)	63	22	0
95th Queue (ft)	112	52	4
Link Distance (ft)	1923		394
Upstream Blk Time (%)			
Queuing Penalty (veh)			
Storage Bay Dist (ft)		150	
Storage Blk Time (%)			
Queuing Penalty (veh)			

Intersection: 300: Virginia Ave & I-526 EB Off-Ramp

Movement	EB	EB
Directions Served	L	R
Maximum Queue (ft)	441	1122
Average Queue (ft)	390	753
95th Queue (ft)	563	1624
Link Distance (ft)		1232
Upstream Blk Time (%)		31
Queuing Penalty (veh)		0
Storage Bay Dist (ft)	350	
Storage Blk Time (%)	70	
Queuing Penalty (veh)	185	

Intersection: 310: Virginia Ave & I-526 WB On-Ramp

Movement	NB	SB
Directions Served	L	R
Maximum Queue (ft)	82	21
Average Queue (ft)	21	1
95th Queue (ft)	56	8
Link Distance (ft)		
Upstream Blk Time (%)		
Queuing Penalty (veh)		
Storage Bay Dist (ft)	225	325
Storage Blk Time (%)		
Queuing Penalty (veh)		

Intersection: 320: Rhett Ave & I-526 EB Ramps

Movement	EB	EB	NB	NB	NB	SB	SB	SB
Directions Served	L	LR	L	T	T	T	T	R
Maximum Queue (ft)	375	636	245	476	416	208	707	788
Average Queue (ft)	332	476	139	155	84	70	108	410
95th Queue (ft)	426	714	252	353	258	165	384	651
Link Distance (ft)		639		684	684	803	803	803
Upstream Blk Time (%)		15		0	0		0	0
Queuing Penalty (veh)		0		0	0		2	1
Storage Bay Dist (ft)	275		150					
Storage Blk Time (%)	24	55	22	2				
Queuing Penalty (veh)	69	121	73	4				

Intersection: 330: Rhett Ave & I-526 WB Ramps

Movement	EB	EB	NB	NB	NB	SB	SB	SB
Directions Served	L	LR	L	T	T	T	T	R
Maximum Queue (ft)	575	797	199	249	273	637	668	425
Average Queue (ft)	562	752	100	118	148	460	624	352
95th Queue (ft)	613	843	175	215	253	720	706	583
Link Distance (ft)		735		803	803	612	612	
Upstream Blk Time (%)		47				3	27	
Queuing Penalty (veh)		0				0	0	
Storage Bay Dist (ft)	475		270					325
Storage Blk Time (%)	11	60		0			29	1
Queuing Penalty (veh)	65	172		0			182	5

Intersection: 340: Morningside Dr/Piedmont Ave & Montague Ave

Movement	EB	EB	EB	B38	B39	B39	WB	WB	WB	WB	NB	NB
Directions Served	L	T	TR	T	T	T	L	T	T	R	LT	R
Maximum Queue (ft)	175	320	374	4	49	183	92	201	184	172	255	150
Average Queue (ft)	38	157	185	0	2	7	33	104	83	80	87	23
95th Queue (ft)	104	292	334	4	50	97	77	166	152	148	185	109
Link Distance (ft)		370	370	1986	538	538		724	724		701	
Upstream Blk Time (%)		0	0									
Queuing Penalty (veh)		0	2									
Storage Bay Dist (ft)	150						175			150		50
Storage Blk Time (%)	0	7						0	0	1	21	0
Queuing Penalty (veh)	0	3						0	1	3	25	0

Intersection: 340: Morningside Dr/Piedmont Ave & Montague Ave

Movement	SB	SB
Directions Served	L	TR
Maximum Queue (ft)	44	87
Average Queue (ft)	11	37
95th Queue (ft)	37	71
Link Distance (ft)		459
Upstream Blk Time (%)		
Queuing Penalty (veh)		
Storage Bay Dist (ft)	135	
Storage Blk Time (%)		
Queuing Penalty (veh)		

Intersection: 350: Montague Ave & Mall Dr/Goer Dr

Movement	EB	EB	EB	WB	WB	NB	NB	NB	NB	NB	SB	SB
Directions Served	L	T	R	L	TR	L	L	T	T	TR	L	T
Maximum Queue (ft)	58	68	150	223	106	221	291	458	448	368	143	274
Average Queue (ft)	16	20	61	100	22	129	156	191	212	145	35	158
95th Queue (ft)	46	53	120	186	74	204	238	372	381	305	90	243
Link Distance (ft)		415	415		476			516	516	516		538
Upstream Blk Time (%)								0	0	0		
Queuing Penalty (veh)								0	0	0		
Storage Bay Dist (ft)	185			170		275	275				175	
Storage Blk Time (%)				3	0	0	0	2			0	5
Queuing Penalty (veh)				1	0	0	0	9			0	2

Intersection: 350: Montague Ave & Mall Dr/Goer Dr

Movement	SB	SB
Directions Served	T	T
Maximum Queue (ft)	285	296
Average Queue (ft)	167	170
95th Queue (ft)	253	267
Link Distance (ft)	538	538
Upstream Blk Time (%)		
Queuing Penalty (veh)		
Storage Bay Dist (ft)		
Storage Blk Time (%)		0
Queuing Penalty (veh)		0

Intersection: 360: Montague Ave & I-26 WB Ramps

Movement	WB	WB	WB	NB	NB	NB	NB	NB	SB	SB	SB	SB
Directions Served	L	L	R	L	L	T	T	T	T	T	T	R
Maximum Queue (ft)	404	470	289	148	167	373	361	295	308	313	334	47
Average Queue (ft)	209	267	63	71	94	222	192	128	171	193	196	3
95th Queue (ft)	349	406	194	132	151	333	304	229	294	316	325	35
Link Distance (ft)		573				845	845	845	516	516	516	
Upstream Blk Time (%)		0										
Queuing Penalty (veh)		0										
Storage Bay Dist (ft)	375		375	550	550							350
Storage Blk Time (%)	0	1									0	
Queuing Penalty (veh)	0	8									0	

Intersection: 370: Montague Ave & I-26 EB Ramps

Movement	NB	B123	SB
Directions Served	T	T	T
Maximum Queue (ft)	6	38	3
Average Queue (ft)	0	1	0
95th Queue (ft)	6	39	3
Link Distance (ft)	422	369	845
Upstream Blk Time (%)		0	
Queuing Penalty (veh)		0	
Storage Bay Dist (ft)			
Storage Blk Time (%)			
Queuing Penalty (veh)			

Intersection: 380: Dorchester Rd & Meeting St

Movement	EB	EB	WB	WB	NB	NB	NB	SB	SB
Directions Served	LT	R	L	TR	L	T	R	LT	TR
Maximum Queue (ft)	148	123	98	74	215	256	120	117	119
Average Queue (ft)	68	62	43	24	105	120	45	55	51
95th Queue (ft)	121	103	84	56	187	220	91	100	96
Link Distance (ft)	457			469		1842	1842	1350	
Upstream Blk Time (%)									
Queuing Penalty (veh)									
Storage Bay Dist (ft)		100	125		125				125
Storage Blk Time (%)	3	1	0		4	6		0	0
Queuing Penalty (veh)	10	1	0		13	16		0	0

Intersection: 390: I-26 WB Ramps & Dorchester Rd

Movement	EB	EB	EB	WB	WB	NB	NB	NB
Directions Served	L	T	T	T	TR	L	L	R
Maximum Queue (ft)	166	220	205	230	240	284	333	30
Average Queue (ft)	61	128	99	120	133	142	207	2
95th Queue (ft)	129	197	165	199	208	275	311	28
Link Distance (ft)	304	304	304	1842	1842			561
Upstream Blk Time (%)								
Queuing Penalty (veh)								
Storage Bay Dist (ft)						530	530	
Storage Blk Time (%)								
Queuing Penalty (veh)								

Intersection: 400: I-26 EB Ramps & Dorchester Rd

Movement	EB	EB	EB	WB	WB	WB	SB	SB
Directions Served	T	T	R	L	T	T	L	R
Maximum Queue (ft)	436	379	307	109	239	249	384	240
Average Queue (ft)	257	198	45	36	140	159	192	21
95th Queue (ft)	390	327	205	86	218	240	318	128
Link Distance (ft)	560	560		304	304	304	445	
Upstream Blk Time (%)	0	0			0		0	
Queuing Penalty (veh)	0	0			0		0	
Storage Bay Dist (ft)			425					300
Storage Blk Time (%)		0	0				1	
Queuing Penalty (veh)		0	0				3	

Intersection: 410: Cosgrove Ave & Azalea Dr

Movement	EB	EB	EB	EB	WB	WB	WB	NB	NB	NB	NB	SB
Directions Served	L	T	T	R	L	T	TR	L	T	T	R	L
Maximum Queue (ft)	225	372	312	232	265	218	126	349	528	554	309	173
Average Queue (ft)	159	166	98	86	128	56	20	238	226	212	55	37
95th Queue (ft)	249	345	254	180	237	147	72	370	422	396	172	116
Link Distance (ft)		892	892			767			661	661	661	
Upstream Blk Time (%)										0	0	
Queuing Penalty (veh)										0	0	
Storage Bay Dist (ft)	130			400	230		600	250				200
Storage Blk Time (%)	32	6	0		3	0		9	2			
Queuing Penalty (veh)	42	13	0		6	0		59	9			

Intersection: 410: Cosgrove Ave & Azalea Dr

Movement	SB	SB	SB
Directions Served	T	T	R
Maximum Queue (ft)	357	450	300
Average Queue (ft)	183	255	82
95th Queue (ft)	310	402	263
Link Distance (ft)	3181	3181	
Upstream Blk Time (%)			
Queuing Penalty (veh)			
Storage Bay Dist (ft)			200
Storage Blk Time (%)	8	26	0
Queuing Penalty (veh)	3	29	0

Intersection: 421: Cosgrove Ave & I-26 WB Ramps

Movement	WB	NB
Directions Served	R	T
Maximum Queue (ft)	192	5
Average Queue (ft)	12	0
95th Queue (ft)	95	5
Link Distance (ft)	473	950
Upstream Blk Time (%)		
Queuing Penalty (veh)		
Storage Bay Dist (ft)		
Storage Blk Time (%)		
Queuing Penalty (veh)		

Intersection: 422: Cosgrove Ave & I-26 EB Ramps

Movement	NB	NB	NB
Directions Served	T	T	TR
Maximum Queue (ft)	911	941	945
Average Queue (ft)	368	913	922
95th Queue (ft)	1065	937	944
Link Distance (ft)	882	882	882
Upstream Blk Time (%)	1	42	76
Queuing Penalty (veh)	0	0	0
Storage Bay Dist (ft)			
Storage Blk Time (%)			
Queuing Penalty (veh)			

Intersection: 430: Bainbridge Ave & Viaduct Rd Ramp

Movement	EB	EB	EB	WB	WB	SB	SB
Directions Served	L	T	T	T	TR	L	LR
Maximum Queue (ft)	67	34	19	7	31	185	217
Average Queue (ft)	15	3	1	0	2	84	104
95th Queue (ft)	47	19	12	8	15	151	183
Link Distance (ft)		789	789	1095	1095	625	625
Upstream Blk Time (%)							
Queuing Penalty (veh)							
Storage Bay Dist (ft)	200						
Storage Blk Time (%)							
Queuing Penalty (veh)							

Intersection: 440: Viaduct Rd & Viaduct Rd Ramp

Movement	WB
Directions Served	R
Maximum Queue (ft)	20
Average Queue (ft)	1
95th Queue (ft)	15
Link Distance (ft)	172
Upstream Blk Time (%)	
Queuing Penalty (veh)	
Storage Bay Dist (ft)	
Storage Blk Time (%)	
Queuing Penalty (veh)	

Intersection: 450: Viaduct Rd & Hobson Ave

Movement	EB	EB	WB	NB
Directions Served	T	R	LT	L
Maximum Queue (ft)	3	52	154	74
Average Queue (ft)	0	4	65	10
95th Queue (ft)	3	26	114	46
Link Distance (ft)	379	379	472	347
Upstream Blk Time (%)				
Queuing Penalty (veh)				
Storage Bay Dist (ft)				
Storage Blk Time (%)				
Queuing Penalty (veh)				

Intersection: 460: Magrath Darby Blvd & US 17

Movement	EB	EB	EB	EB	EB	WB	WB	WB	WB	NB	SB
Directions Served	L	T	T	T	R	L	T	T	R	R	R
Maximum Queue (ft)	366	692	639	577	153	139	1220	1261	616	214	106
Average Queue (ft)	164	303	259	220	32	44	387	396	33	94	39
95th Queue (ft)	389	762	694	610	169	99	1018	1042	295	172	84
Link Distance (ft)		1105	1105	1105			1292	1292	1292	516	538
Upstream Blk Time (%)		2	1	1			0	0			
Queuing Penalty (veh)		0	0	0			0	1			
Storage Bay Dist (ft)	375				175	205					
Storage Blk Time (%)		11		7			3				
Queuing Penalty (veh)		16		10			2				

Intersection: 470: Houston Northcutt Blvd/Mathis Ferry Rd & US 17

Movement	EB	EB	EB	EB	EB	EB	WB	WB	WB	WB	WB	WB
Directions Served	L	L	T	T	T	R	L	L	T	T	T	R
Maximum Queue (ft)	465	515	1212	1239	1205	315	313	450	1754	1764	1193	230
Average Queue (ft)	419	461	829	788	703	190	187	342	768	801	704	89
95th Queue (ft)	540	600	1526	1492	1370	408	302	554	1529	1516	1249	259
Link Distance (ft)			1292	1292	1292				4040	4040	4040	
Upstream Blk Time (%)			8	2	1							
Queuing Penalty (veh)			78	16	7							
Storage Bay Dist (ft)	415	415				215	350	350				130
Storage Blk Time (%)	29	50	3		23	0	1	2	35		36	
Queuing Penalty (veh)	215	373	16		80	1	8	20	126		49	

Intersection: 470: Houston Northcutt Blvd/Mathis Ferry Rd & US 17

Movement	NB	NB	NB	NB	SB	SB	SB	SB
Directions Served	L	T	T	R	L	T	T	R
Maximum Queue (ft)	214	416	349	223	259	541	538	369
Average Queue (ft)	159	205	143	102	119	370	342	124
95th Queue (ft)	242	379	298	194	373	598	587	388
Link Distance (ft)		543	543	543	536	536	536	
Upstream Blk Time (%)		0			5	16	15	
Queuing Penalty (veh)		0			0	0	0	
Storage Bay Dist (ft)	115							300
Storage Blk Time (%)	37	22					40	
Queuing Penalty (veh)	49	38					32	

Intersection: 480: Shelmore Blvd & US 17

Movement	EB	EB	EB	EB	EB	WB	WB	WB	WB	WB	NB	NB
Directions Served	L	T	T	T	R	L	T	T	T	R	L	T
Maximum Queue (ft)	458	1024	850	432	240	478	816	683	698	300	259	260
Average Queue (ft)	294	217	213	197	32	197	449	473	495	216	219	180
95th Queue (ft)	465	737	651	364	148	399	705	644	671	420	294	314
Link Distance (ft)		4040	4040	4040			2558	2558	2558		231	231
Upstream Blk Time (%)		0	0								52	20
Queuing Penalty (veh)		0	0								0	0
Storage Bay Dist (ft)	400				210	400				200		
Storage Blk Time (%)	12	0		5		0	13		37			56
Queuing Penalty (veh)	82	0		9		0	27		113			105

Intersection: 480: Shelmore Blvd & US 17

Movement	NB	SB	SB	SB	SB
Directions Served	R	L	L	T	R
Maximum Queue (ft)	190	175	356	356	251
Average Queue (ft)	101	142	251	242	93
95th Queue (ft)	231	225	402	397	204
Link Distance (ft)			333	333	333
Upstream Blk Time (%)			27	18	0
Queuing Penalty (veh)			0	0	0
Storage Bay Dist (ft)	90	75			
Storage Blk Time (%)	10	57	82		
Queuing Penalty (veh)	21	58	84		

Intersection: 490: Dragoon Dr & US 17

Movement	EB	EB	EB	EB	WB	WB	WB	WB	NB	NB
Directions Served	T	T	T	R	L	T	T	T	L	R
Maximum Queue (ft)	364	382	406	300	143	676	845	237	130	140
Average Queue (ft)	184	197	218	55	68	114	135	130	55	63
95th Queue (ft)	331	337	362	216	122	416	479	234	108	120
Link Distance (ft)	2558	2558	2558			1813	1813	1813		228
Upstream Blk Time (%)						0	0			
Queuing Penalty (veh)						0	0			
Storage Bay Dist (ft)				200	200				125	
Storage Blk Time (%)			8		0	0			1	1
Queuing Penalty (veh)			10		1	0			1	1

Intersection: 500: Anna Knapp Blvd & US 17

Movement	EB	EB	EB	EB	EB	WB	WB	WB	WB	WB	NB	NB
Directions Served	L	T	T	T	R	L	T	T	T	R	L	LT
Maximum Queue (ft)	451	652	662	594	275	470	1521	1516	1520	300	221	202
Average Queue (ft)	324	270	266	228	56	289	1385	1375	1370	237	127	122
95th Queue (ft)	487	665	611	437	216	585	1744	1743	1767	422	204	190
Link Distance (ft)		1813	1813	1813			1466	1466	1466		325	325
Upstream Blk Time (%)							28	23	34			
Queuing Penalty (veh)							0	0	0			
Storage Bay Dist (ft)	365				175	370				200		
Storage Blk Time (%)	20	1		14		0	39		41			
Queuing Penalty (veh)	134	2		17		0	77		168			

Intersection: 500: Anna Knapp Blvd & US 17

Movement	NB	NB	SB	SB	SB	SB
Directions Served	T	R	L	LT	T	R
Maximum Queue (ft)	210	205	175	306	257	245
Average Queue (ft)	47	92	169	273	145	99
95th Queue (ft)	159	170	186	305	257	194
Link Distance (ft)	325			260	260	260
Upstream Blk Time (%)				75	0	1
Queuing Penalty (veh)				0	0	0
Storage Bay Dist (ft)		140	75			
Storage Blk Time (%)	1	4	82	93		
Queuing Penalty (veh)	2	2	143	114		

Intersection: 510: Local Access Rd & Bainbridge Ave

Movement	EB	EB	EB	EB	WB	WB	WB	NB	NB	NB	SB	SB
Directions Served	L	T	T	R	L	T	TR	L	T	TR	L	T
Maximum Queue (ft)	45	210	215	114	93	116	129	133	16	72	24	24
Average Queue (ft)	6	118	124	40	34	56	53	54	1	22	2	2
95th Queue (ft)	28	181	185	83	75	99	107	103	7	53	14	13
Link Distance (ft)		1095	1095			754	754		1254	1254		641
Upstream Blk Time (%)												
Queuing Penalty (veh)												
Storage Bay Dist (ft)	150			150	150			250			250	
Storage Blk Time (%)		2	2		0	0						
Queuing Penalty (veh)		0	2		0	0						

Intersection: 510: Local Access Rd & Bainbridge Ave

Movement	SB
Directions Served	TR
Maximum Queue (ft)	30
Average Queue (ft)	3
95th Queue (ft)	17
Link Distance (ft)	641
Upstream Blk Time (%)	
Queuing Penalty (veh)	
Storage Bay Dist (ft)	
Storage Blk Time (%)	
Queuing Penalty (veh)	

Intersection: 520: Local Access Rd & Stromboli Ave

Movement	EB	EB	EB	NB	NB	NB	SB	SB
Directions Served	L	L	R	L	T	T	T	TR
Maximum Queue (ft)	75	55	33	32	68	48	33	55
Average Queue (ft)	25	22	9	3	17	10	2	17
95th Queue (ft)	57	49	31	18	50	37	16	48
Link Distance (ft)		1627	1627		1431	1431	1254	1254
Upstream Blk Time (%)								
Queuing Penalty (veh)								
Storage Bay Dist (ft)	200			200				
Storage Blk Time (%)								
Queuing Penalty (veh)								

Intersection: 530: Local Access Rd & PAR SB Ramp

Movement
Directions Served
Maximum Queue (ft)
Average Queue (ft)
95th Queue (ft)
Link Distance (ft)
Upstream Blk Time (%)
Queuing Penalty (veh)
Storage Bay Dist (ft)
Storage Blk Time (%)
Queuing Penalty (veh)

Intersection: 540: PAR NB Ramp/Tidewater Rd & Local Access Rd

Movement	EB	WB	SB
Directions Served	LTR	LTR	L
Maximum Queue (ft)	78	30	11
Average Queue (ft)	45	9	0
95th Queue (ft)	69	29	6
Link Distance (ft)	616	871	222
Upstream Blk Time (%)			
Queuing Penalty (veh)			
Storage Bay Dist (ft)			
Storage Blk Time (%)			
Queuing Penalty (veh)			

Network Summary

Network wide Queuing Penalty: 4189

Intersection: 10: Rivers Ave SB & I-526 WB Ramps

Movement	WB	WB	SB	SB	SB
Directions Served	T	T	T	T	T
Maximum Queue (ft)	132	132	188	117	77
Average Queue (ft)	59	62	93	38	26
95th Queue (ft)	106	107	157	83	62
Link Distance (ft)	136	136	1224	1224	1224
Upstream Blk Time (%)	0	0			
Queuing Penalty (veh)	0	0			
Storage Bay Dist (ft)					
Storage Blk Time (%)					
Queuing Penalty (veh)					

Intersection: 11: Rivers Ave NB/Rivers Ave & I-526 WB Ramps

Movement
Directions Served
Maximum Queue (ft)
Average Queue (ft)
95th Queue (ft)
Link Distance (ft)
Upstream Blk Time (%)
Queuing Penalty (veh)
Storage Bay Dist (ft)
Storage Blk Time (%)
Queuing Penalty (veh)

Intersection: 20: Rivers Ave NB & I-526 EB Ramps

Movement	EB	EB	NB	NB	NB	NB	B27
Directions Served	T	T	T	T	T	R	T
Maximum Queue (ft)	146	162	155	150	168	83	64
Average Queue (ft)	72	84	69	68	77	9	2
95th Queue (ft)	124	136	132	130	142	49	66
Link Distance (ft)	157	157	1619	1619	1619		751
Upstream Blk Time (%)	0	0					
Queuing Penalty (veh)	0	0					
Storage Bay Dist (ft)						350	
Storage Blk Time (%)							
Queuing Penalty (veh)							

Intersection: 21: Rivers Ave SB & I-526 EB Ramps

Movement
Directions Served
Maximum Queue (ft)
Average Queue (ft)
95th Queue (ft)
Link Distance (ft)
Upstream Blk Time (%)
Queuing Penalty (veh)
Storage Bay Dist (ft)
Storage Blk Time (%)
Queuing Penalty (veh)

Intersection: 30: Rivers Ave SB & Mall Dr

Movement	EB	EB	NB	SB	SB	SB	SB
Directions Served	T	R	L	T	T	T	R
Maximum Queue (ft)	406	225	138	252	225	202	128
Average Queue (ft)	220	57	55	143	121	94	47
95th Queue (ft)	344	184	111	225	197	173	96
Link Distance (ft)	1458		122	2788	2788	2788	
Upstream Blk Time (%)			1				
Queuing Penalty (veh)			1				
Storage Bay Dist (ft)		125					140
Storage Blk Time (%)	30					2	0
Queuing Penalty (veh)	19					5	0

Intersection: 31: Rivers Ave NB & Mall Dr Left

Movement	NB
Directions Served	T
Maximum Queue (ft)	2
Average Queue (ft)	0
95th Queue (ft)	2
Link Distance (ft)	338
Upstream Blk Time (%)	
Queuing Penalty (veh)	
Storage Bay Dist (ft)	
Storage Blk Time (%)	
Queuing Penalty (veh)	

Intersection: 32: Rivers Ave NB & Rivers Ave NB Left

Movement
Directions Served
Maximum Queue (ft)
Average Queue (ft)
95th Queue (ft)
Link Distance (ft)
Upstream Blk Time (%)
Queuing Penalty (veh)
Storage Bay Dist (ft)
Storage Blk Time (%)
Queuing Penalty (veh)

Intersection: 33: Rivers Ave SB

Movement	WB	SB	SB
Directions Served	R	T	T
Maximum Queue (ft)	2	5	2
Average Queue (ft)	0	0	0
95th Queue (ft)	3	5	2
Link Distance (ft)	73	122	122
Upstream Blk Time (%)			
Queuing Penalty (veh)			
Storage Bay Dist (ft)			
Storage Blk Time (%)			
Queuing Penalty (veh)			

Intersection: 40: Rivers Ave NB & WB Montague Ramps

Movement	WB	WB	NB	NB	NB	SB
Directions Served	T	R	T	T	TR	L
Maximum Queue (ft)	33	311	230	242	261	133
Average Queue (ft)	3	128	39	56	70	49
95th Queue (ft)	18	238	130	141	161	111
Link Distance (ft)	470		346	346	346	76
Upstream Blk Time (%)					0	5
Queuing Penalty (veh)					0	4
Storage Bay Dist (ft)		380				
Storage Blk Time (%)		0				
Queuing Penalty (veh)		0				

Intersection: 41: Rivers Ave SB & WB Montague Ramps

Movement			
Directions Served			
Maximum Queue (ft)			
Average Queue (ft)			
95th Queue (ft)			
Link Distance (ft)			
Upstream Blk Time (%)			
Queuing Penalty (veh)			
Storage Bay Dist (ft)			
Storage Blk Time (%)			
Queuing Penalty (veh)			

Intersection: 42: Rivers Ave NB

Movement	EB	NB	NB
Directions Served	R	T	T
Maximum Queue (ft)	32	2	2
Average Queue (ft)	1	0	0
95th Queue (ft)	18	2	2
Link Distance (ft)	109	76	76
Upstream Blk Time (%)	0		
Queuing Penalty (veh)	0		
Storage Bay Dist (ft)			
Storage Blk Time (%)			
Queuing Penalty (veh)			

Intersection: 43: Rivers Ave SB & Montague Ramp Left

Movement			
Directions Served			
Maximum Queue (ft)			
Average Queue (ft)			
95th Queue (ft)			
Link Distance (ft)			
Upstream Blk Time (%)			
Queuing Penalty (veh)			
Storage Bay Dist (ft)			
Storage Blk Time (%)			
Queuing Penalty (veh)			

Intersection: 50: Rivers Ave NB & Morningside Dr

Movement	WB	WB	NB	NB	NB	NB	SB
Directions Served	T	R	T	T	T	R	L
Maximum Queue (ft)	250	93	220	237	301	220	125
Average Queue (ft)	135	34	95	117	146	56	68
95th Queue (ft)	226	74	183	207	253	154	125
Link Distance (ft)	701		666	666	666		61
Upstream Blk Time (%)							22
Queuing Penalty (veh)							22
Storage Bay Dist (ft)		425				120	
Storage Blk Time (%)					13	0	
Queuing Penalty (veh)					21	0	

Intersection: 51: Rivers Ave SB & Morningside Dr

Movement
Directions Served
Maximum Queue (ft)
Average Queue (ft)
95th Queue (ft)
Link Distance (ft)
Upstream Blk Time (%)
Queuing Penalty (veh)
Storage Bay Dist (ft)
Storage Blk Time (%)
Queuing Penalty (veh)

Intersection: 52: Rivers Ave NB

Movement	EB	NB	NB
Directions Served	R	T	T
Maximum Queue (ft)	80	7	3
Average Queue (ft)	9	0	0
95th Queue (ft)	47	8	0
Link Distance (ft)	60	61	61
Upstream Blk Time (%)	1		
Queuing Penalty (veh)	1		
Storage Bay Dist (ft)			
Storage Blk Time (%)			
Queuing Penalty (veh)			

Intersection: 53: Rivers Ave SB & Morningside Dr Left

Movement
Directions Served
Maximum Queue (ft)
Average Queue (ft)
95th Queue (ft)
Link Distance (ft)
Upstream Blk Time (%)
Queuing Penalty (veh)
Storage Bay Dist (ft)
Storage Blk Time (%)
Queuing Penalty (veh)

Intersection: 55: Rivers Ave/Rivers Ave SB & Rivers Ave NB

Movement	SB	SB	SB	SB
Directions Served	T	T	T	T
Maximum Queue (ft)	56	61	16	17
Average Queue (ft)	2	2	1	1
95th Queue (ft)	57	57	11	9
Link Distance (ft)	560	560	560	560
Upstream Blk Time (%)		0		
Queuing Penalty (veh)		0		
Storage Bay Dist (ft)				
Storage Blk Time (%)				
Queuing Penalty (veh)				

Intersection: 60: Rivers Ave & Piggly Wiggly Dr

Movement	EB	EB	EB	NB	NB	NB	NB	SB	SB	SB	SB
Directions Served	L	L	R	L	T	T	T	T	T	T	R
Maximum Queue (ft)	174	309	135	69	111	134	152	149	172	146	71
Average Queue (ft)	37	132	18	22	38	50	72	58	78	64	30
95th Queue (ft)	128	238	99	56	92	111	140	129	153	133	63
Link Distance (ft)		468			2162	2162	2162	716	716	716	
Upstream Blk Time (%)		0									
Queuing Penalty (veh)		0									
Storage Bay Dist (ft)	75		50	125							425
Storage Blk Time (%)	1	42			0						
Queuing Penalty (veh)	1	67			0						

Intersection: 70: Rivers Ave & Meeting St/Durant Ave

Movement	EB	EB	WB	WB	WB	NB	NB	NB	SB	SB	SB	SB
Directions Served	L	TR	L	T	R	LT	T	TR	L	T	T	R
Maximum Queue (ft)	150	276	188	158	101	273	294	324	175	242	255	108
Average Queue (ft)	98	125	95	54	35	147	159	199	73	116	131	41
95th Queue (ft)	162	227	162	127	73	250	264	307	141	204	218	84
Link Distance (ft)		460		552		673	673			2162	2162	2162
Upstream Blk Time (%)												
Queuing Penalty (veh)												
Storage Bay Dist (ft)	50		125		150			300	725			
Storage Blk Time (%)	39	26	7	1	0		0	1				
Queuing Penalty (veh)	65	42	16	3	0		1	3				

Intersection: 80: Rivers Ave & Helm Ave

Movement	EB	WB	NB	NB	NB	SB	SB	SB
Directions Served	LTR	LTR	L	T	TR	L	T	TR
Maximum Queue (ft)	52	128	41	252	264	59	184	211
Average Queue (ft)	16	47	11	111	142	15	73	90
95th Queue (ft)	41	93	32	208	235	44	151	174
Link Distance (ft)	737	713		3153	3153		2604	2604
Upstream Blk Time (%)								
Queuing Penalty (veh)								
Storage Bay Dist (ft)			225			200		
Storage Blk Time (%)				0			0	
Queuing Penalty (veh)				0			0	

Intersection: 90: Rivers Ave #2/Rivers Ave & McMillan Ave

Movement	EB	EB	WB	WB	NB	NB	NB	NB	SB	SB	SB	SB
Directions Served	LT	TR	LT	R	L	T	T	R	L	T	T	R
Maximum Queue (ft)	104	64	334	305	38	262	264	109	174	188	218	60
Average Queue (ft)	27	6	166	122	5	142	155	40	52	55	95	13
95th Queue (ft)	77	34	289	246	22	235	246	82	128	139	187	39
Link Distance (ft)	1091	1091	1517	1517		981	981			3153	3153	
Upstream Blk Time (%)												
Queuing Penalty (veh)												
Storage Bay Dist (ft)					200			200	200			200
Storage Blk Time (%)						3	4		0	0	1	
Queuing Penalty (veh)						1	7		0	0	0	

Intersection: 100: Rivers Ave #2 & Dorchester Rd

Movement	EB	EB	NB	NB	NB	SB	SB	SB
Directions Served	L	R	L	T	T	T	T	R
Maximum Queue (ft)	241	177	219	130	117	124	152	74
Average Queue (ft)	109	54	95	24	42	48	61	28
95th Queue (ft)	192	120	173	75	89	101	121	61
Link Distance (ft)	1350			658	658	981	981	
Upstream Blk Time (%)								
Queuing Penalty (veh)								
Storage Bay Dist (ft)		100	185					200
Storage Blk Time (%)	11	0	1	0			0	
Queuing Penalty (veh)	13	0	7	0			0	

Intersection: 110: Rivers Ave #2 & Cosgrove Ave

Movement	EB	EB	EB	WB	WB	WB	NB	NB	NB	SB	SB	SB
Directions Served	L	T	TR	L	T	TR	L	T	TR	L	T	T
Maximum Queue (ft)	513	430	209	264	746	758	300	620	519	236	339	393
Average Queue (ft)	307	124	81	70	488	514	255	312	256	59	181	170
95th Queue (ft)	494	298	176	231	775	799	345	581	424	161	319	343
Link Distance (ft)		3181	3181		1391	1391		1140	1140		658	658
Upstream Blk Time (%)												
Queuing Penalty (veh)												
Storage Bay Dist (ft)	450			165			200			200		
Storage Blk Time (%)	5	0			63		35	9		0	13	23
Queuing Penalty (veh)	10	0			22		107	28		0	8	74

Intersection: 110: Rivers Ave #2 & Cosgrove Ave

Movement	SB
Directions Served	R
Maximum Queue (ft)	218
Average Queue (ft)	108
95th Queue (ft)	224
Link Distance (ft)	
Upstream Blk Time (%)	
Queuing Penalty (veh)	
Storage Bay Dist (ft)	125
Storage Blk Time (%)	2
Queuing Penalty (veh)	5

Intersection: 120: Rivers Ave #2 & Reynolds Ave

Movement	EB	WB	NB	NB	NB	SB	SB	SB	SB
Directions Served	LTR	LTR	L	T	TR	L	T	T	R
Maximum Queue (ft)	230	262	117	244	226	127	101	64	36
Average Queue (ft)	116	137	35	123	108	48	27	15	5
95th Queue (ft)	206	232	85	219	202	99	76	51	24
Link Distance (ft)	666	1494		1257	1257		1140	1140	
Upstream Blk Time (%)									
Queuing Penalty (veh)									
Storage Bay Dist (ft)			200			200			50
Storage Blk Time (%)				2			0	2	0
Queuing Penalty (veh)				1			0	1	0

Intersection: 130: Rivers Ave/Rivers Ave #2 & Carner Ave #2

Movement	WB	NB	NB	SB	SB
Directions Served	R	T	TR	L	T
Maximum Queue (ft)	348	37	66	314	151
Average Queue (ft)	134	3	19	149	14
95th Queue (ft)	263	18	54	273	151
Link Distance (ft)	2094	773	773		1257
Upstream Blk Time (%)					
Queuing Penalty (veh)					
Storage Bay Dist (ft)				250	
Storage Blk Time (%)				4	
Queuing Penalty (veh)				4	

Intersection: 140: Carner Ave #2 & Burton Ln

Movement	EB	WB	WB	NB	NB	NB	SB	SB
Directions Served	LTR	LT	R	L	T	R	L	TR
Maximum Queue (ft)	77	143	114	37	200	139	82	166
Average Queue (ft)	29	55	39	4	100	18	27	70
95th Queue (ft)	61	115	85	22	173	69	65	138
Link Distance (ft)	572	1388			222			2094
Upstream Blk Time (%)					0			
Queuing Penalty (veh)					1			
Storage Bay Dist (ft)			190	120		50	170	
Storage Blk Time (%)		0	0		19	0		0
Queuing Penalty (veh)		0	0		7	1		0

Intersection: 150: Carner Ave/Carner Ave #2 & Stromboli Ave

Movement	WB	WB	WB	NB	NB	SB	SB	SB
Directions Served	L	L	R	T	TR	L	T	T
Maximum Queue (ft)	3	41	46	96	30	35	60	71
Average Queue (ft)	0	5	8	17	2	4	8	6
95th Queue (ft)	3	25	33	65	13	21	35	37
Link Distance (ft)		1754	1754	1034	1034		671	671
Upstream Blk Time (%)								
Queuing Penalty (veh)								
Storage Bay Dist (ft)	300					250		
Storage Blk Time (%)								
Queuing Penalty (veh)								

Intersection: 160: Spruill Ave & Montague Ave

Movement	EB	EB	WB	WB	NB	NB	SB	SB
Directions Served	L	TR	L	TR	L	TR	L	TR
Maximum Queue (ft)	48	191	111	142	195	186	39	74
Average Queue (ft)	12	78	50	58	86	81	10	30
95th Queue (ft)	39	144	92	114	152	153	34	66
Link Distance (ft)		450		1923		680		573
Upstream Blk Time (%)								
Queuing Penalty (veh)								
Storage Bay Dist (ft)	125		75		275		90	
Storage Blk Time (%)		2	2	4		0		0
Queuing Penalty (veh)		0	4	5		0		0

Intersection: 170: Spruill Ave #1/Spruill Ave & McMillan Ave

Movement	EB	EB	EB	WB	WB	WB	NB	NB	SB	SB	SB
Directions Served	L	T	TR	L	T	TR	L	TR	L	T	R
Maximum Queue (ft)	156	117	127	238	229	228	410	670	62	285	142
Average Queue (ft)	70	46	45	211	104	127	194	484	12	120	28
95th Queue (ft)	148	96	101	275	189	212	455	723	40	219	89
Link Distance (ft)		1517	1517	220	220	220		652		774	
Upstream Blk Time (%)				40	0	0		1			
Queuing Penalty (veh)				105	1	1		12			
Storage Bay Dist (ft)	225						310		275		200
Storage Blk Time (%)	0							26		1	
Queuing Penalty (veh)	0							45		1	

Intersection: 180: Spruill Ave #1 & Cosgrove Ave

Movement	EB	EB	EB	WB	WB	WB	NB	NB	SB	SB	SB
Directions Served	L	T	TR	L	T	TR	L	TR	L	T	R
Maximum Queue (ft)	325	832	310	21	59	32	360	1402	34	265	287
Average Queue (ft)	292	395	47	3	14	2	278	1003	6	121	59
95th Queue (ft)	387	972	183	12	42	17	488	1602	25	229	209
Link Distance (ft)		1391	1391		1117	1117		1405		652	
Upstream Blk Time (%)								1			
Queuing Penalty (veh)								8			
Storage Bay Dist (ft)	225			30			260		140		280
Storage Blk Time (%)	54			0	4		0	57		4	1
Queuing Penalty (veh)	17			0	1		1	96		23	3

Intersection: 190: Spruill Ave #1 & Reynolds Ave

Movement	EB	WB	WB	NB	NB	SB	SB
Directions Served	LTR	L	TR	L	TR	L	TR
Maximum Queue (ft)	182	27	89	263	743	48	243
Average Queue (ft)	85	4	33	89	263	13	86
95th Queue (ft)	160	20	71	228	658	40	194
Link Distance (ft)	1494		716		2143		1405
Upstream Blk Time (%)							
Queuing Penalty (veh)							
Storage Bay Dist (ft)		200		185		180	
Storage Blk Time (%)				0	14		1
Queuing Penalty (veh)				0	17		0

Intersection: 200: Spruill Ave #1 & Carolina Ave

Movement	WB	NB	NB	SB
Directions Served	L	T	R	T
Maximum Queue (ft)	98	273	134	158
Average Queue (ft)	41	111	13	51
95th Queue (ft)	81	229	82	128
Link Distance (ft)	573	2062		2143
Upstream Blk Time (%)				
Queuing Penalty (veh)				
Storage Bay Dist (ft)			50	
Storage Blk Time (%)		12		
Queuing Penalty (veh)		10		

Intersection: 210: Spruill Ave #1 & Burton Ln/Viaduct Rd

Movement	EB	EB	WB	WB	WB	NB	NB	SB	SB
Directions Served	LT	TR	L	T	R	L	TR	L	TR
Maximum Queue (ft)	65	72	226	622	191	208	428	214	379
Average Queue (ft)	15	16	98	101	96	25	196	79	132
95th Queue (ft)	47	51	186	378	164	98	357	179	408
Link Distance (ft)		1388		1596			1278		2062
Upstream Blk Time (%)				0					
Queuing Penalty (veh)				1					
Storage Bay Dist (ft)	250		340		250	150		170	
Storage Blk Time (%)				0	0		14	6	2
Queuing Penalty (veh)				0	0		4	24	2

Intersection: 220: Spruill Ave/Spruill Ave #1 & Stromboli Ave

Movement	EB	EB	EB	WB	WB	WB	NB	NB	SB	SB
Directions Served	L	T	TR	L	T	TR	L	TR	L	TR
Maximum Queue (ft)	41	33	50	44	14	58	46	217	63	215
Average Queue (ft)	9	2	9	14	0	16	8	94	18	103
95th Queue (ft)	32	16	35	38	6	41	30	179	49	188
Link Distance (ft)		1754	1754		1627	1627		518		1278
Upstream Blk Time (%)										
Queuing Penalty (veh)										
Storage Bay Dist (ft)	250			250			250		250	
Storage Blk Time (%)								0		0
Queuing Penalty (veh)								0		0

Intersection: 230: McMillan Ave & St Johns Ave

Movement	EB	EB	WB	WB	SB
Directions Served	LT	T	T	TR	LR
Maximum Queue (ft)	133	26	267	218	527
Average Queue (ft)	59	1	87	29	342
95th Queue (ft)	111	12	232	134	680
Link Distance (ft)	220	220	1999	1999	517
Upstream Blk Time (%)					45
Queuing Penalty (veh)					0
Storage Bay Dist (ft)					
Storage Blk Time (%)					
Queuing Penalty (veh)					

Intersection: 240: Noisette Blvd & McMillan Ave

Movement	EB	EB	WB	WB	NB	SB	SB
Directions Served	LT	TR	LT	TR	LTR	LT	R
Maximum Queue (ft)	105	16	18	2	40	106	126
Average Queue (ft)	39	0	1	0	13	41	70
95th Queue (ft)	79	8	9	2	39	81	107
Link Distance (ft)	1999	1999	324	324	535	1291	1291
Upstream Blk Time (%)							
Queuing Penalty (veh)							
Storage Bay Dist (ft)							
Storage Blk Time (%)							
Queuing Penalty (veh)							

Intersection: 250: Hobson Ave & McMillan Ave

Movement	EB	EB	WB	NB	SB	SB
Directions Served	LT	R	LTR	LT	LT	TR
Maximum Queue (ft)	52	71	42	73	24	19
Average Queue (ft)	23	38	11	19	1	1
95th Queue (ft)	48	61	36	54	11	10
Link Distance (ft)	324	324	721	578	583	583
Upstream Blk Time (%)						
Queuing Penalty (veh)						
Storage Bay Dist (ft)						
Storage Blk Time (%)						
Queuing Penalty (veh)						

Intersection: 260: Noisette Blvd & Turnbull Ave

Movement	EB	WB	WB	NB	NB	SB
Directions Served	LTR	LT	R	LT	R	LTR
Maximum Queue (ft)	120	29	71	146	52	112
Average Queue (ft)	57	11	33	73	12	59
95th Queue (ft)	94	33	56	118	38	95
Link Distance (ft)	550	315		1291	1291	2516
Upstream Blk Time (%)						
Queuing Penalty (veh)						
Storage Bay Dist (ft)			75			
Storage Blk Time (%)			0			
Queuing Penalty (veh)			0			

Intersection: 270: Noisette Blvd & Avenue B

Movement	WB	NB	SB
Directions Served	LR	TR	LT
Maximum Queue (ft)	98	1	62
Average Queue (ft)	44	0	10
95th Queue (ft)	77	1	41
Link Distance (ft)	564	1116	593
Upstream Blk Time (%)			
Queuing Penalty (veh)			
Storage Bay Dist (ft)			
Storage Blk Time (%)			
Queuing Penalty (veh)			

Intersection: 280: Virginia Ave & Avenue B

Movement	WB	NB	SB
Directions Served	L	TR	L
Maximum Queue (ft)	62	21	71
Average Queue (ft)	23	1	24
95th Queue (ft)	47	12	57
Link Distance (ft)	593	466	1266
Upstream Blk Time (%)			
Queuing Penalty (veh)			
Storage Bay Dist (ft)			
Storage Blk Time (%)	0		
Queuing Penalty (veh)	0		

Intersection: 290: Virginia Ave & Montague Ave

Movement	EB	NB	SB
Directions Served	LR	L	TR
Maximum Queue (ft)	117	79	11
Average Queue (ft)	53	27	0
95th Queue (ft)	93	61	6
Link Distance (ft)	1923		394
Upstream Blk Time (%)			
Queuing Penalty (veh)			
Storage Bay Dist (ft)		150	
Storage Blk Time (%)			
Queuing Penalty (veh)			

Intersection: 300: Virginia Ave & I-526 EB Off-Ramp

Movement	EB	EB	NB	NB
Directions Served	L	R	T	T
Maximum Queue (ft)	303	421	272	200
Average Queue (ft)	116	135	65	45
95th Queue (ft)	322	618	378	316
Link Distance (ft)		1232	1357	1357
Upstream Blk Time (%)		3		
Queuing Penalty (veh)		0		
Storage Bay Dist (ft)	350			
Storage Blk Time (%)	10	0		
Queuing Penalty (veh)	9	0		

Intersection: 310: Virginia Ave & I-526 WB On-Ramp

Movement	NB	NB	NB	SB	SB
Directions Served	L	T	T	T	R
Maximum Queue (ft)	324	564	464	7	129
Average Queue (ft)	205	178	128	0	40
95th Queue (ft)	371	602	497	5	95
Link Distance (ft)		593	593	492	
Upstream Blk Time (%)		7	1		
Queuing Penalty (veh)		25	3		
Storage Bay Dist (ft)	225				325
Storage Blk Time (%)	32	0			
Queuing Penalty (veh)	62	0			

Intersection: 320: Rhett Ave & I-526 EB Ramps

Movement	EB	EB	NB	NB	NB	SB	SB	SB
Directions Served	L	LR	L	T	T	T	T	R
Maximum Queue (ft)	375	618	250	557	495	176	252	591
Average Queue (ft)	310	413	160	222	160	92	95	238
95th Queue (ft)	423	615	272	456	386	152	191	457
Link Distance (ft)		639		684	684	803	803	803
Upstream Blk Time (%)		4		0	0		0	
Queuing Penalty (veh)		0		0	0		0	
Storage Bay Dist (ft)	275		150					
Storage Blk Time (%)	5	37	31	6				
Queuing Penalty (veh)	22	113	140	11				

Intersection: 330: Rhett Ave & I-526 WB Ramps

Movement	EB	EB	NB	NB	NB	SB	SB	SB
Directions Served	L	LR	L	T	T	T	T	R
Maximum Queue (ft)	575	786	144	272	282	629	652	425
Average Queue (ft)	541	705	51	150	158	350	456	279
95th Queue (ft)	643	877	106	237	245	621	728	546
Link Distance (ft)		735		803	803	612	612	
Upstream Blk Time (%)		27				1	11	
Queuing Penalty (veh)		0				0	0	
Storage Bay Dist (ft)	475		270					325
Storage Blk Time (%)	3	43	0	0			21	2
Queuing Penalty (veh)	20	174	0	0			112	11

Intersection: 340: Morningside Dr/Piedmont Ave & Montague Ave

Movement	EB	EB	EB	B38	B39	B39	B39	WB	WB	WB	WB	NB
Directions Served	L	T	TR	T	T	T		L	T	T	R	LT
Maximum Queue (ft)	203	305	357	5	293	428	54	124	171	180	193	267
Average Queue (ft)	72	148	171	0	14	25	0	48	94	81	91	115
95th Queue (ft)	152	274	315	5	150	210	0	102	148	148	163	216
Link Distance (ft)		370	370	1986	538	538	538		724	724		701
Upstream Blk Time (%)		0	0		0	0	0					
Queuing Penalty (veh)		0	2		0	0	0					
Storage Bay Dist (ft)	150							175			150	
Storage Blk Time (%)	2	6						0	0	0	1	33
Queuing Penalty (veh)	9	6						1	0	1	5	44

Intersection: 340: Morningside Dr/Piedmont Ave & Montague Ave

Movement	NB	SB	SB
Directions Served	R	L	TR
Maximum Queue (ft)	150	55	77
Average Queue (ft)	35	17	29
95th Queue (ft)	138	47	60
Link Distance (ft)			459
Upstream Blk Time (%)			
Queuing Penalty (veh)			
Storage Bay Dist (ft)	50	135	
Storage Blk Time (%)	0		0
Queuing Penalty (veh)	0		0

Intersection: 350: Montague Ave & Mall Dr/Goer Dr

Movement	EB	EB	EB	WB	WB	NB	NB	NB	NB	NB	SB	SB
Directions Served	L	T	R	L	TR	L	L	T	T	TR	L	T
Maximum Queue (ft)	159	441	458	269	415	193	348	476	510	498	96	268
Average Queue (ft)	44	315	396	178	88	76	122	253	277	207	21	159
95th Queue (ft)	104	621	537	288	287	142	260	427	452	406	62	243
Link Distance (ft)		415	415		476			516	516	516		538
Upstream Blk Time (%)		39	72		0			0	0	0		
Queuing Penalty (veh)		0	0		0			1	1	1		
Storage Bay Dist (ft)	185			170		275	275				175	
Storage Blk Time (%)				13	0		0	7				5
Queuing Penalty (veh)				8	0		0	18				1

Intersection: 350: Montague Ave & Mall Dr/Goer Dr

Movement	SB	SB
Directions Served	T	T
Maximum Queue (ft)	283	301
Average Queue (ft)	173	172
95th Queue (ft)	257	269
Link Distance (ft)	538	538
Upstream Blk Time (%)		
Queuing Penalty (veh)		
Storage Bay Dist (ft)		
Storage Blk Time (%)		0
Queuing Penalty (veh)		0

Intersection: 360: Montague Ave & I-26 WB Ramps

Movement	WB	WB	WB	NB	NB	NB	NB	NB	SB	SB	SB	SB
Directions Served	L	L	R	L	L	T	T	T	T	T	T	R
Maximum Queue (ft)	473	623	475	386	403	288	259	209	471	478	490	383
Average Queue (ft)	357	458	191	225	245	173	161	107	295	313	319	36
95th Queue (ft)	515	668	557	343	363	251	237	190	436	437	459	195
Link Distance (ft)		573				845	845	845	516	516	516	
Upstream Blk Time (%)		10							0	0	0	
Queuing Penalty (veh)		0							0	0	2	
Storage Bay Dist (ft)	375		375	550	550							350
Storage Blk Time (%)	3	23									4	
Queuing Penalty (veh)	23	151									10	

Intersection: 370: Montague Ave & I-26 EB Ramps

Movement	B123	B123	SB	SB	SB
Directions Served	T	T	T	T	R
Maximum Queue (ft)	38	38	32	38	2
Average Queue (ft)	3	1	0	1	0
95th Queue (ft)	56	39	4	27	2
Link Distance (ft)	369	369	845	845	845
Upstream Blk Time (%)	0	0			
Queuing Penalty (veh)	0	0			
Storage Bay Dist (ft)					
Storage Blk Time (%)					
Queuing Penalty (veh)					

Intersection: 380: Dorchester Rd & Meeting St

Movement	EB	EB	WB	WB	NB	NB	NB	SB	SB
Directions Served	LT	R	L	TR	L	T	R	LT	TR
Maximum Queue (ft)	145	179	157	142	210	219	112	184	174
Average Queue (ft)	57	82	77	42	104	96	40	97	89
95th Queue (ft)	107	140	133	102	178	181	82	161	149
Link Distance (ft)	457			469		1842	1842	1350	
Upstream Blk Time (%)									
Queuing Penalty (veh)									
Storage Bay Dist (ft)		100	125		125				125
Storage Blk Time (%)	2	5	2	0	5	3		3	2
Queuing Penalty (veh)	7	4	2	1	13	9		6	4

Intersection: 390: I-26 WB Ramps & Dorchester Rd

Movement	EB	EB	EB	WB	WB	NB	NB
Directions Served	L	T	T	T	TR	L	L
Maximum Queue (ft)	306	156	140	389	417	342	387
Average Queue (ft)	179	82	46	216	247	171	227
95th Queue (ft)	289	135	103	333	368	300	336
Link Distance (ft)	304	304	304	1842	1842		
Upstream Blk Time (%)	1						
Queuing Penalty (veh)	2						
Storage Bay Dist (ft)						530	530
Storage Blk Time (%)							
Queuing Penalty (veh)							

Intersection: 400: I-26 EB Ramps & Dorchester Rd

Movement	EB	EB	EB	WB	WB	WB	SB	SB
Directions Served	T	T	R	L	T	T	L	R
Maximum Queue (ft)	510	420	210	166	220	245	247	141
Average Queue (ft)	312	237	12	61	149	160	115	13
95th Queue (ft)	461	393	100	130	213	234	208	77
Link Distance (ft)	560	560		304	304	304	445	
Upstream Blk Time (%)	0	0						
Queuing Penalty (veh)	0	0						
Storage Bay Dist (ft)			425					300
Storage Blk Time (%)		0					0	
Queuing Penalty (veh)		0					0	

Intersection: 410: Cosgrove Ave & Azalea Dr

Movement	EB	EB	EB	EB	WB	WB	WB	NB	NB	NB	NB	SB
Directions Served	L	T	T	R	L	T	TR	L	T	T	R	L
Maximum Queue (ft)	216	843	914	500	330	822	700	347	487	435	192	175
Average Queue (ft)	117	313	588	443	306	614	523	218	178	138	35	24
95th Queue (ft)	216	877	1244	607	398	1019	934	354	391	306	129	120
Link Distance (ft)		892	892			767			661	661	661	
Upstream Blk Time (%)		2	45			38			0		0	
Queuing Penalty (veh)		0	0			0			0		0	
Storage Bay Dist (ft)	130			400	230		600	250				200
Storage Blk Time (%)	27	4	0	60	80	0	1	12	0			
Queuing Penalty (veh)	21	4	0	46	298	0	6	50	1			

Intersection: 410: Cosgrove Ave & Azalea Dr

Movement	SB	SB	SB
Directions Served	T	T	R
Maximum Queue (ft)	535	564	300
Average Queue (ft)	299	344	124
95th Queue (ft)	543	590	344
Link Distance (ft)	3181	3181	
Upstream Blk Time (%)			
Queuing Penalty (veh)			
Storage Bay Dist (ft)			200
Storage Blk Time (%)	20	30	0
Queuing Penalty (veh)	6	44	0

Intersection: 421: Cosgrove Ave & I-26 WB Ramps

Movement	WB
Directions Served	R
Maximum Queue (ft)	38
Average Queue (ft)	2
95th Queue (ft)	31
Link Distance (ft)	473
Upstream Blk Time (%)	
Queuing Penalty (veh)	
Storage Bay Dist (ft)	
Storage Blk Time (%)	
Queuing Penalty (veh)	

Intersection: 422: Cosgrove Ave & I-26 EB Ramps

Movement	NB	NB	NB	SB	SB
Directions Served	T	T	TR	T	R
Maximum Queue (ft)	710	928	940	142	131
Average Queue (ft)	110	427	508	7	5
95th Queue (ft)	580	1155	1203	116	93
Link Distance (ft)	882	882	882	950	950
Upstream Blk Time (%)	0	14	29		
Queuing Penalty (veh)	0	0	0		
Storage Bay Dist (ft)					
Storage Blk Time (%)					
Queuing Penalty (veh)					

Intersection: 430: Bainbridge Ave & Viaduct Rd Ramp

Movement	EB	EB	WB	WB	SB	SB
Directions Served	L	T	T	TR	L	LR
Maximum Queue (ft)	56	7	8	16	136	167
Average Queue (ft)	18	0	0	1	50	77
95th Queue (ft)	48	4	6	8	105	141
Link Distance (ft)		789	1095	1095	625	625
Upstream Blk Time (%)						
Queuing Penalty (veh)						
Storage Bay Dist (ft)	200					
Storage Blk Time (%)						
Queuing Penalty (veh)						

Intersection: 440: Viaduct Rd & Viaduct Rd Ramp

Movement	EB	B6	B6
Directions Served	R	T	
Maximum Queue (ft)	225	157	6
Average Queue (ft)	44	14	0
95th Queue (ft)	176	86	6
Link Distance (ft)	145	601	601
Upstream Blk Time (%)	3		
Queuing Penalty (veh)	19		
Storage Bay Dist (ft)			
Storage Blk Time (%)			
Queuing Penalty (veh)			

Intersection: 450: Viaduct Rd & Hobson Ave

Movement	EB	WB	NB
Directions Served	R	LT	L
Maximum Queue (ft)	80	119	62
Average Queue (ft)	9	58	5
95th Queue (ft)	47	97	29
Link Distance (ft)	379	472	347
Upstream Blk Time (%)			
Queuing Penalty (veh)			
Storage Bay Dist (ft)			
Storage Blk Time (%)			
Queuing Penalty (veh)			

Intersection: 460: Magrath Darby Blvd & US 17

Movement	EB	EB	EB	EB	EB	WB	WB	WB	WB	NB	SB
Directions Served	L	T	T	T	R	L	T	T	R	R	R
Maximum Queue (ft)	402	896	841	840	247	304	1327	1313	765	290	123
Average Queue (ft)	184	444	412	373	66	85	529	591	46	145	45
95th Queue (ft)	424	1094	1060	1001	256	220	1268	1327	411	252	94
Link Distance (ft)		1105	1105	1105			1292	1292	1292	516	538
Upstream Blk Time (%)		6	2	3			0	0	0		
Queuing Penalty (veh)		0	0	0			1	2	0		
Storage Bay Dist (ft)	375				175	205					
Storage Blk Time (%)		12		14		0	8				
Queuing Penalty (veh)		14		22		0	6				

Intersection: 470: Houston Northcutt Blvd/Mathis Ferry Rd & US 17

Movement	EB	EB	EB	EB	EB	EB	WB	WB	WB	WB	WB	WB
Directions Served	L	L	T	T	T	R	L	L	T	T	T	R
Maximum Queue (ft)	448	515	1257	1254	1266	315	398	450	2341	2145	2117	230
Average Queue (ft)	357	430	857	868	866	194	329	415	1202	1226	1156	78
95th Queue (ft)	536	622	1505	1499	1494	425	476	537	2240	2230	2203	243
Link Distance (ft)			1292	1292	1292				4040	4040	4040	
Upstream Blk Time (%)			1	1	1							
Queuing Penalty (veh)			11	8	8							
Storage Bay Dist (ft)	415	415				215	350	350				130
Storage Blk Time (%)	18	30	16		33		32	50	30		25	
Queuing Penalty (veh)	156	263	70		106		228	357	93		34	

Intersection: 470: Houston Northcutt Blvd/Mathis Ferry Rd & US 17

Movement	NB	NB	NB	NB	SB	SB	SB	SB
Directions Served	L	T	T	R	L	T	T	R
Maximum Queue (ft)	214	432	355	432	274	324	286	245
Average Queue (ft)	178	240	162	237	127	209	172	104
95th Queue (ft)	248	449	344	384	249	377	355	236
Link Distance (ft)		543	543	543	536	536	536	
Upstream Blk Time (%)		1	0	0	0	3	2	
Queuing Penalty (veh)		0	0	0	0	0	0	
Storage Bay Dist (ft)	115							300
Storage Blk Time (%)	49	19					8	
Queuing Penalty (veh)	66	43					14	

Intersection: 480: Shelmore Blvd & US 17

Movement	EB	EB	EB	EB	EB	WB	WB	WB	WB	WB	NB	NB
Directions Served	L	T	T	T	R	L	T	T	T	R	L	T
Maximum Queue (ft)	480	1270	1992	921	310	488	762	764	748	300	256	254
Average Queue (ft)	311	404	460	434	131	357	472	467	447	155	230	151
95th Queue (ft)	477	940	1192	811	364	570	845	823	765	379	294	299
Link Distance (ft)		4040	4040	4040			2558	2558	2558		231	231
Upstream Blk Time (%)		0	0								74	19
Queuing Penalty (veh)		0	0								0	0
Storage Bay Dist (ft)	400				210	400				200		
Storage Blk Time (%)	5	6		35		30	6		32			48
Queuing Penalty (veh)	43	20		43		228	12		59			129

Intersection: 480: Shelmore Blvd & US 17

Movement	NB	SB	SB	SB	SB
Directions Served	R	L	L	T	R
Maximum Queue (ft)	190	175	358	349	249
Average Queue (ft)	97	160	298	255	77
95th Queue (ft)	229	204	415	428	204
Link Distance (ft)			333	333	333
Upstream Blk Time (%)			43	32	1
Queuing Penalty (veh)			0	0	0
Storage Bay Dist (ft)	90	75			
Storage Blk Time (%)	17	76	91		
Queuing Penalty (veh)	30	87	103		

Intersection: 490: Dragoon Dr & US 17

Movement	EB	EB	EB	EB	WB	WB	WB	WB	NB	NB
Directions Served	T	T	T	R	L	T	T	T	L	R
Maximum Queue (ft)	207	435	450	54	227	406	1176	878	189	240
Average Queue (ft)	86	137	136	10	117	121	181	167	86	127
95th Queue (ft)	177	458	374	37	203	318	643	515	170	232
Link Distance (ft)	2558	2558	2558			1813	1813	1813		228
Upstream Blk Time (%)						0	0	0	0	3
Queuing Penalty (veh)						0	0	0	0	0
Storage Bay Dist (ft)				200	200				125	
Storage Blk Time (%)			2		1	0			10	17
Queuing Penalty (veh)			2		11	0			15	13

Intersection: 500: Anna Knapp Blvd & US 17

Movement	EB	EB	EB	EB	EB	WB	WB	WB	WB	WB	NB	NB
Directions Served	L	T	T	T	R	L	T	T	T	R	L	LT
Maximum Queue (ft)	406	517	549	544	275	470	1196	1160	1150	300	180	186
Average Queue (ft)	250	295	328	352	94	376	726	685	630	173	92	104
95th Queue (ft)	398	461	484	508	292	572	1244	1195	1131	402	159	168
Link Distance (ft)		1813	1813	1813			1466	1466	1466		325	325
Upstream Blk Time (%)							1	1	1			
Queuing Penalty (veh)							0	0	0			
Storage Bay Dist (ft)	365				175	370				200		
Storage Blk Time (%)	4	2		33		22	26		33			
Queuing Penalty (veh)	44	5		43		176	52		89			

Intersection: 500: Anna Knapp Blvd & US 17

Movement	NB	NB	SB	SB	SB	SB
Directions Served	T	R	L	LT	T	R
Maximum Queue (ft)	250	226	175	304	265	200
Average Queue (ft)	61	127	171	278	165	76
95th Queue (ft)	200	213	183	290	265	157
Link Distance (ft)	325			260	260	260
Upstream Blk Time (%)				90	4	0
Queuing Penalty (veh)				0	0	0
Storage Bay Dist (ft)		140	75			
Storage Blk Time (%)	3	10	75	92		
Queuing Penalty (veh)	6	5	194	159		

Intersection: 510: Local Access Rd & Bainbridge Ave

Movement	EB	EB	EB	EB	WB	WB	WB	NB	NB	NB	SB	SB
Directions Served	L	T	T	R	L	T	TR	L	T	TR	L	T
Maximum Queue (ft)	37	126	121	110	153	198	188	115	16	39	26	24
Average Queue (ft)	5	57	62	49	69	103	97	42	1	8	2	1
95th Queue (ft)	23	101	107	87	128	168	160	88	8	26	13	12
Link Distance (ft)		1095	1095			754	754		1254	1254		641
Upstream Blk Time (%)												
Queuing Penalty (veh)												
Storage Bay Dist (ft)	150			150	150			250			250	
Storage Blk Time (%)		0	0	0	0	1						
Queuing Penalty (veh)		0	0	0	1	1						

Intersection: 510: Local Access Rd & Bainbridge Ave

Movement	SB
Directions Served	TR
Maximum Queue (ft)	33
Average Queue (ft)	7
95th Queue (ft)	27
Link Distance (ft)	641
Upstream Blk Time (%)	
Queuing Penalty (veh)	
Storage Bay Dist (ft)	
Storage Blk Time (%)	
Queuing Penalty (veh)	

Intersection: 520: Local Access Rd & Stromboli Ave

Movement	EB	EB	EB	NB	NB	NB	SB	SB
Directions Served	L	L	R	L	T	T	T	TR
Maximum Queue (ft)	80	42	33	36	55	35	27	67
Average Queue (ft)	25	11	5	4	13	4	2	22
95th Queue (ft)	59	35	24	22	42	20	16	58
Link Distance (ft)		1627	1627		1431	1431	1254	1254
Upstream Blk Time (%)								
Queuing Penalty (veh)								
Storage Bay Dist (ft)	200			200				
Storage Blk Time (%)								
Queuing Penalty (veh)								

Intersection: 530: Local Access Rd & PAR SB Ramp

Movement	SB
Directions Served	TR
Maximum Queue (ft)	12
Average Queue (ft)	0
95th Queue (ft)	9
Link Distance (ft)	1431
Upstream Blk Time (%)	
Queuing Penalty (veh)	
Storage Bay Dist (ft)	
Storage Blk Time (%)	
Queuing Penalty (veh)	

Intersection: 540: PAR NB Ramp/Tidewater Rd & Local Access Rd

Movement	EB	WB	SB
Directions Served	LTR	LTR	L
Maximum Queue (ft)	60	30	3
Average Queue (ft)	35	7	0
95th Queue (ft)	54	25	3
Link Distance (ft)	616	871	222
Upstream Blk Time (%)			
Queuing Penalty (veh)			
Storage Bay Dist (ft)			
Storage Blk Time (%)			
Queuing Penalty (veh)			

Network Summary

Network wide Queuing Penalty: 5551

Appendix E
Traffic Analysis Worksheets

2018 Opening Year

Build River Center Site Alternatives 5-7

Appendix E
Traffic Analysis Worksheets

2018 Opening Year

Build River Center Site Alternatives 5-7

Interstate 26

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-26 EB
Agency or Company	Atkins	Junction	1010-EB Off to C-D
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2018 Build - River Center Site

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Freeway Number of Lanes, N: 4	☐ Yes ☐ On
☑ No ☐ Off	Ramp Number of Lanes, N: 1	☑ No ☐ Off
L_{up} = ft	Acceleration Lane Length, L_A	L_{down} = ft
V_u = veh/h	Deceleration Lane Length L_D: 400	V_D = veh/h
	Freeway Volume, V_F: 8422	
	Ramp Volume, V_R: 1010	
	Freeway Free-Flow Speed, S_{FF}: 60.0	
	Ramp Free-Flow Speed, S_{FR}: 55.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	8422	0.90	Level	14	0	0.935	1.00	10013
Ramp	1010	0.90	Level	7	0	0.966	1.00	1161
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 0.436 using Equation (Exhibit 13-7)

V_{12} = 5020 pc/h

V_3 or V_{av34} 2496 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	10013	Exhibit 13-8	9200	Yes
$V_{FO} = V_F - V_R$	8852	Exhibit 13-8	9200	No
V_R	1161	Exhibit 13-10	2200	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	5020	Exhibit 13-8	4400:All	Yes

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = 43.8 (pc/mi/ln)

LOS = F (Exhibit 13-2)

Speed Determination

D_s = 0.272 (Exhibit 13-12)

S_R= 55.1 mph (Exhibit 13-12)

S_0= 60.0 mph (Exhibit 13-12)

S = 57.4 mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-26 EB
Agency or Company	Atkins	Junction	1010-EB Off to C-D
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2018 Build - River Center Site

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp
☐ Yes ☐ On
☑ No ☐ Off
L_{up} = ft
V_u = veh/h

Freeway Number of Lanes, N	4
Ramp Number of Lanes, N	1
Acceleration Lane Length, L_A	
Deceleration Lane Length L_D	400
Freeway Volume, V_F	5636
Ramp Volume, V_R	540
Freeway Free-Flow Speed, S_{FF}	60.0
Ramp Free-Flow Speed, S_{FR}	55.0

Downstream Adj Ramp
☐ Yes ☐ On
☑ No ☐ Off
L_{down} = ft
V_D = veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	5636	0.90	Level	11	0	0.948	1.00	6607
Ramp	540	0.90	Level	12	0	0.943	1.00	636
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)
P_{FM} = using Equation (Exhibit 13-6)
V_{12} = pc/h
V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)
Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No
Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No
If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = (pc/mi/ln)
LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)
S_R= mph (Exhibit 13-11)
S_0= mph (Exhibit 13-11)
S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)
P_{FD} = 0.436 using Equation (Exhibit 13-7)
V_{12} = 3239 pc/h
V_3 or V_{av34} 1684 pc/h (Equation 13-14 or 13-17)
Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No
Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No
If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	6607	Exhibit 13-8	9200	No
$V_{FO} = V_F - V_R$	5971	Exhibit 13-8	9200	No
V_R	636	Exhibit 13-10	2200	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	3239	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = 28.5 (pc/mi/ln)
LOS = D (Exhibit 13-2)

Speed Determination

D_s = 0.225 (Exhibit 13-12)
S_R= 55.9 mph (Exhibit 13-12)
S_0= 63.2 mph (Exhibit 13-12)
S = 59.4 mph (Exhibit 13-13)

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-26 EB*
Agency or Company	*Atkins*	From/To	*1015-Avai/Rem CD Off to CD On*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2018 Build - River Center Site*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*7412*	veh/h	Peak-Hour Factor, PHF	*0.90*	
AADT		veh/day	%Trucks and Buses, P_T	*15*	
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*	
Peak-Hr Direction Prop, D			General Terrain:	*Level*	
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*	

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.930*

Speed Inputs			Calc Speed Adj and FFS		
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f_{LW}		mph
Number of Lanes, N	*4*		f_{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	*60.0*	mph	FFS	*60.0*	mph
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures			Design (N)	
Operational (LOS)			Design (N)	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*2213*	pc/h/ln	Design LOS	
			v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h/ln
S	*53.2*	mph	S	mph
D = v_p / S	*41.6*	pc/mi/ln	D = v_p / S	pc/mi/ln
LOS	*E*		Required Number of Lanes, N	

Glossary		Factor Location	
N - Number of lanes	S - Speed	E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
V - Hourly volume	D - Density	E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 11-18	TRD - Page 11-11
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 11-2, 11-3	
DDHV - Directional design hour volume			

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-26 EB*
Agency or Company	*Atkins*	From/To	*1015-Avai/Rem CD Off to CD On*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*PM Peak*	Analysis Year	*2018 Build - River Center Site*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*5096*	veh/h	Peak-Hour Factor, PHF	*0.90*	
AADT		veh/day	%Trucks and Buses, P_T	*12*	
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*	
Peak-Hr Direction Prop, D			General Terrain:	*Level*	
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*	

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.943*

Speed Inputs			Calc Speed Adj and FFS		
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f_{LW}		mph
Number of Lanes, N	*4*		f_{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	*60.0*	mph	FFS	*60.0*	mph
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures			Design (N)	
Operational (LOS)			Design (N)	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1500*	pc/h/ln	Design LOS	
			v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h/ln
S	*60.0*	mph	S	mph
D = v_p / S	*25.0*	pc/mi/ln	D = v_p / S	pc/mi/ln
LOS	*C*		Required Number of Lanes, N	

Glossary		Factor Location	
N - Number of lanes	S - Speed	E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
V - Hourly volume	D - Density	E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 11-18	TRD - Page 11-11
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 11-2, 11-3	
DDHV - Directional design hour volume			

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RAMP ADD OR DROP LANE ANALYSIS (MAINLINE <55 MPH)

ATKINS

General Information

Date Performed:	7/25/2014	Freeway/Direction	I-26 EB C-D
Analysis Year	2018 Build-River Center Site	Junction	EB Off to Aviation Ave
Analysis Time Period:	AM Peak	Segment ID	1020
Project Description:	Navy Base ICTF		

Inputs

	Mainline Upstream Ramp	Mainline Downstream Ramp	Ramp
Number of Lanes, N	1	1	1
Free-Flow Speed, FFS (mph)	55	55	45
Volume, V (veh/h)	1,010	484	526
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	7%	7%	7%
%RVs, P_R	0%	0%	0%

Performance Measures

	Upstream of Off-Ramp	Downstream of Off-Ramp	Off-Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.97	0.97	0.97
Demand Flow Rate, v_p (pc/h/ln)	1,162	557	605
Capacity Flow Rate, c (pc/h/ln)	2,200	2,200	2,100
v/c ratio	0.53	0.25	0.29
Density, D_{MD} (pc/mi/ln)	20.3	9.7	10.6
LOS	C	A	B

Formulas and Reference Material

$$f_{HV} = \frac{1}{1+P_T(E_T-1)+P_R(E_R-1)}$$ HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P}$$ HCM 2010, Equation 11-2

$$D_{MD} = \frac{0.0175*v_f}{N}$$ HCM 2010, Equation 13-26

Ramp Roadways Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

Diverge LOS Thresholds

LOS	Density (pc/mi/ln)
A	≤10
B	>10-20
C	>20-28
D	>28-35
E	>35
F	v/c > 1

Source: HCM 2010, Exhibit 13-2

RAMP ADD OR DROP LANE ANALYSIS (MAINLINE <55 MPH)

ATKINS

General Information

Date Performed:	7/25/2014	Freeway/Direction	I-26 EB C-D
Analysis Year	2018 Build-River Center Site	Junction	EB Off to Aviation Ave
Analysis Time Period:	PM Peak	Segment ID	1020
Project Description:	Navy Base ICTF		

Inputs

	Mainline Upstream Ramp	Mainline Downstream Ramp	Ramp
Number of Lanes, N	1	1	1
Free-Flow Speed, FFS (mph)	55	55	45
Volume, V (veh/h)	540	317	223
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	12%	9%	15%
%RVs, P_R	0%	0%	0%

Performance Measures

	Upstream of Off-Ramp	Downstream of Off-Ramp	Off-Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.94	0.96	0.93
Demand Flow Rate, v_p (pc/h/ln)	636	368	266
Capacity Flow Rate, c (pc/h/ln)	2,200	2,200	2,100
v/c ratio	0.29	0.17	0.13
Density, D_{MD} (pc/mi/ln)	11.1	6.4	4.7
LOS	B	A	A

Formulas and Reference Material

$$f_{HV} = \frac{1}{1+P_T(E_T-1)+P_R(E_R-1)}$$ HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P}$$ HCM 2010, Equation 11-2

$$D_{MD} = \frac{0.0175*v_f}{N}$$ HCM 2010, Equation 13-26

Ramp Roadways Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

Diverge LOS Thresholds

LOS	Density (pc/mi/ln)
A	≤10
B	>10-20
C	>20-28
D	>28-35
E	>35
F	v/c > 1

Source: HCM 2010, Exhibit 13-2

BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-26 EB C-D*
Agency or Company	*Atkins*	From/To	*1025 - Avia Off to Avia WB On*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2018 Build - River Center Site*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*968*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*7*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.966*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*55.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*55.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*557*	pc/h/ln
S	*55.0*	mph
D = v_p / S	*10.1*	pc/mi/ln
LOS	*A*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-26 EB C-D*
Agency or Company	*Atkins*	From/To	*1025 - Avia Off to Avia WB On*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*PM Peak*	Analysis Year	*2018 Build - River Center Site*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*634*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*9*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.957*

Speed Inputs			Calc Speed Adj and FFS		
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f_{LW}		mph
Number of Lanes, N	*2*		f_{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	*55.0*	mph	FFS	*55.0*	mph
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures			Design (N)	
Operational (LOS)			Design (N)	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*368*	pc/h/ln	Design LOS	
			v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h/ln
S	*55.0*	mph	S	mph
D = v_p / S	*6.7*	pc/mi/ln	D = v_p / S	pc/mi/ln
LOS	*A*		Required Number of Lanes, N	

Glossary		Factor Location	
N - Number of lanes	S - Speed	E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
V - Hourly volume	D - Density	E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 11-18	TRD - Page 11-11
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 11-2, 11-3	
DDHV - Directional design hour volume			

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F-3759

RAMP ADD OR DROP LANE ANALYSIS (MAINLINE <55 MPH)

ATKINS

General Information

Date Performed:	7/25/2014	Freeway/Direction	I-26 EB C-D
Analysis Year	2018 Build-River Center Site	Junction	WB Aviation EB On Loop
Analysis Time Period:	AM Peak	Segment ID	1030
Project Description:	Navy Base ICTF		

Inputs

	Mainline Upstream Ramp	Mainline Downstream Ramp	Ramp
Number of Lanes, N	1	1	1
Free-Flow Speed, FFS (mph)	55	55	25
Volume, V (veh/h)	484	780	296
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	7%	6%	3%
%RVs, P_R	0%	0%	0%

Performance Measures

	Upstream of Off-Ramp	Downstream of Off-Ramp	Off-Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.97	0.97	0.99
Demand Flow Rate, v_p (pc/h/ln)	557	893	334
Capacity Flow Rate, c (pc/h/ln)	2,200	2,200	1,900
v/c ratio	0.25	0.41	0.18
Density, D_{MD} (pc/mi/ln)	9.7	15.6	5.8
LOS	A	B	A

Formulas and Reference Material

$$f_{HV} = \frac{1}{1+P_T(E_T-1)+P_R(E_R-1)}$$ HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P}$$ HCM 2010, Equation 11-2

$$D_{MD} = \frac{0.0175*v_f}{N}$$ HCM 2010, Equation 13-26

Ramp Roadways Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

Diverge LOS Thresholds

LOS	Density (pc/mi/ln)
A	≤10
B	>10-20
C	>20-28
D	>28-35
E	>35
F	v/c > 1

Source: HCM 2010, Exhibit 13-2

RAMP ADD OR DROP LANE ANALYSIS (MAINLINE <55 MPH)

ATKINS

General Information

Date Performed:	7/25/2014	Freeway/Direction	I-26 EB C-D
Analysis Year	2018 Build-River Center Site	Junction	WB Aviation EB On Loop
Analysis Time Period:	PM Peak	Segment ID	1030
Project Description:	Navy Base ICTF		

Inputs

	Mainline Upstream Ramp	Mainline Downstream Ramp	Ramp
Number of Lanes, N	1	1	1
Free-Flow Speed, FFS (mph)	55	55	25
Volume, V (veh/h)	317	788	471
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	9%	5%	2%
%RVs, P_R	0%	0%	0%

Performance Measures

	Upstream of Off-Ramp	Downstream of Off-Ramp	Off-Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.96	0.98	0.99
Demand Flow Rate, v_p (pc/h/ln)	368	897	529
Capacity Flow Rate, c (pc/h/ln)	2,200	2,200	1,900
v/c ratio	0.17	0.41	0.28
Density, D_{MD} (pc/mi/ln)	6.4	15.7	9.3
LOS	A	B	A

Formulas and Reference Material

$$f_{HV} = \frac{1}{1+P_T(E_T-1)+P_R(E_R-1)}$$ HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P}$$ HCM 2010, Equation 11-2

$$D_{MD} = \frac{0.0175*v_f}{N}$$ HCM 2010, Equation 13-26

Ramp Roadways Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

Diverge LOS Thresholds

LOS	Density (pc/mi/ln)
A	≤10
B	>10-20
C	>20-28
D	>28-35
E	>35
F	v/c > 1

Source: HCM 2010, Exhibit 13-2

Navy Base ICTF

FREEWAY WEAVING WORKSHEET

General Information

Analyst	AJR
Agency/Company	Atkins
Date Performed	7/25/2014
Analysis Time Period	AM Peak

Site Information

Freeway/Dir of Travel	I-26 EB - Aviation-Remount C-D
Weaving Segment Location	1040-EB Aviation to Remount
Analysis Year	2018 Build - River Center Site

Project Description *Navy Base ICTF*

Inputs

Weaving configuration	One-Sided
Weaving number of lanes, N	2
Weaving segment length, L_S	535ft
Freeway free-flow speed, FFS	55 mph
Segment type	C-D Roadway/ Multilane Highways
Freeway minimum speed, S_{MIN}	15
Freeway maximum capacity, C_{IFL}	2250
Terrain type	Level

Conversions to pc/h Under Base Conditions

	V (veh/h)	PHF	Truck (%)	RV (%)	E_T	E_R	f_{HV}	f_p	v (pc/h)
V_{FF}	296	0.90	3	0	1.5	1.2	0.985	1.00	334
V_{RF}	209	0.90	7	0	1.5	1.2	0.966	1.00	240
V_{FR}	484	0.90	7	0	1.5	1.2	0.966	1.00	557
V_{RR}	0	0.90	0	0	1.5	1.2	1.000	1.00	0
V_{NW}	334							V =	1131
V_W	797								
VR	0.705								

Configuration Characteristics

Minimum maneuver lanes, N_{WL}	2 lc	Minimum weaving lane changes, LC_{MIN}	797 lc/h
Interchange density, ID	0.8 int/mi	Weaving lane changes, LC_W	835 lc/h
Minimum RF lane changes, LC_{RF}	1 lc/pc	Non-weaving lane changes, LC_{NW}	0 lc/h
Minimum FR lane changes, LC_{FR}	1 lc/pc	Total lane changes, LC_{ALL}	835 lc/h
Minimum RR lane changes, LC_{RR}	lc/pc	Non-weaving vehicle index, I_{NW}	14

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment flow rate, v	1131 pc/h	Weaving intensity factor, W	0.321
Weaving segment capacity, c_w	2960 veh/h	Weaving segment speed, S	45.6 mph
Weaving segment v/c ratio	0.376	Average weaving speed, S_W	45.3 mph
Weaving segment density, D	12.4 pc/mi/ln	Average non-weaving speed, S_{NW}	46.5 mph
Level of Service, LOS	B	Maximum weaving length, L_{MAX}	10315 ft

Notes

a. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments".
b. For volumes that exceed the weaving segment capacity, the level of service is "F".

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Navy Base ICTF

FREEWAY WEAVING WORKSHEET

General Information

Analyst	AJR
Agency/Company	Atkins
Date Performed	7/25//2014
Analysis Time Period	PM Peak

Site Information

Freeway/Dir of Travel	I-26 EB - Aviation-Remount C-D
Weaving Segment Location	1040-EB Aviation to Remount
Analysis Year	2018 Build - River Center Site

Project Description *Navy Base ICTF*

Inputs

Weaving configuration	One-Sided
Weaving number of lanes, N	2
Weaving segment length, L_S	535ft
Freeway free-flow speed, FFS	55 mph
Segment type	C-D Roadway/ Multilane Highways
Freeway minimum speed, S_{MIN}	15
Freeway maximum capacity, C_{IFL}	2250
Terrain type	Level

Conversions to pc/h Under Base Conditions

	V (veh/h)	PHF	Truck (%)	RV (%)	E_T	E_R	f_{HV}	f_p	v (pc/h)
V_{FF}	471	0.90	2	0	1.5	1.2	0.990	1.00	529
V_{RF}	373	0.90	3	0	1.5	1.2	0.985	1.00	421
V_{FR}	317	0.90	9	0	1.5	1.2	0.957	1.00	368
V_{RR}	0	0.90	0	0	1.5	1.2	1.000	1.00	0
V_{NW}	529							V =	1318
V_W	789								
VR	0.599								

Configuration Characteristics

Minimum maneuver lanes, N_{WL}	2 lc	Minimum weaving lane changes, LC_{MIN}	789 lc/h
Interchange density, ID	0.8 int/mi	Weaving lane changes, LC_W	827 lc/h
Minimum RF lane changes, LC_{RF}	1 lc/pc	Non-weaving lane changes, LC_{NW}	14 lc/h
Minimum FR lane changes, LC_{FR}	1 lc/pc	Total lane changes, LC_{ALL}	841 lc/h
Minimum RR lane changes, LC_{RR}	lc/pc	Non-weaving vehicle index, I_{NW}	23

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment flow rate, v	1318 pc/h	Weaving intensity factor, W	0.323
Weaving segment capacity, c_w	3172 veh/h	Weaving segment speed, S	45.6 mph
Weaving segment v/c ratio	0.411	Average weaving speed, S_W	45.2 mph
Weaving segment density, D	14.5 pc/mi/ln	Average non-weaving speed, S_{NW}	46.2 mph
Level of Service, LOS	B	Maximum weaving length, L_{MAX}	9002 ft

Notes

a. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments".
b. For volumes that exceed the weaving segment capacity, the level of service is "F".

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-26 EB C-D*
Agency or Company	*Atkins*	From/To	*1045-Remount Off to Remount On*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2018 Build - River Center Site*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*1010*	veh/h	Peak-Hour Factor, PHF	*0.90*	
AADT		veh/day	%Trucks and Buses, P_T	*5*	
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*	
Peak-Hr Direction Prop, D			General Terrain:	*Level*	
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*	

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.976*

Speed Inputs			Calc Speed Adj and FFS		
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f_{LW}		mph
Number of Lanes, N	*2*		f_{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	*55.0*	mph	FFS	*55.0*	mph
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures			Design (N)	
Operational (LOS)			Design (N)	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*575*	pc/h/ln	Design LOS	
S	*55.0*	mph	v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h/ln
D = v_p / S	*10.5*	pc/mi/ln	S	mph
LOS	*A*		D = v_p / S	pc/mi/ln
			Required Number of Lanes, N	

Glossary		Factor Location	
N - Number of lanes	S - Speed	E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
V - Hourly volume	D - Density	E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 11-18	TRD - Page 11-11
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 11-2, 11-3	
DDHV - Directional design hour volume			

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-26 EB C-D*
Agency or Company	*Atkins*	From/To	*1045-Remount Off to Remount On*
Date Performed	*4/25/2014*	Jurisdiction	
Analysis Time Period	*PM Peak*	Analysis Year	*2018 Build - River Center Site*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*1688*	veh/h	Peak-Hour Factor, PHF	*0.90*	
AADT		veh/day	%Trucks and Buses, P_T	*2*	
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*	
Peak-Hr Direction Prop, D			General Terrain:	*Level*	
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*	

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.990*

Speed Inputs			Calc Speed Adj and FFS		
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f_{LW}		mph
Number of Lanes, N	*2*		f_{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	*55.0*	mph	FFS	*55.0*	mph
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures			Design (N)		
Operational (LOS)			Design (N)		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*947*	pc/h/ln	Design LOS		
S	*55.0*	mph	v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
D = v_p / S	*17.2*	pc/mi/ln	S		mph
LOS	*B*		D = v_p / S		pc/mi/ln
			Required Number of Lanes, N		

Glossary		Factor Location	
N - Number of lanes	S - Speed	E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
V - Hourly volume	D - Density	E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 11-18	TRD - Page 11-11
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 11-2, 11-3	
DDHV - Directional design hour volume			

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RAMP ADD OR DROP LANE ANALYSIS (MAINLINE <55 MPH)

ATKINS

General Information

Date Performed:	7/25/2014	Freeway/Direction	I-26 EB C-D
Analysis Year	2018 Build-River Center Site	Junction	Remount EB On Loop
Analysis Time Period:	AM Peak	Segment ID	1050
Project Description:	Navy Base ICTF		

Inputs

	Mainline Upstream Ramp	Mainline Downstream Ramp	Ramp
Number of Lanes, N	1	1	1
Free-Flow Speed, FFS (mph)	55	55	25
Volume, V (veh/h)	505	852	347
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	5%	4%	3%
%RVs, P_R	0%	0%	0%

Performance Measures

	Upstream of Off-Ramp	Downstream of Off-Ramp	Off-Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.98	0.98	0.99
Demand Flow Rate, v_p (pc/h/ln)	575	966	391
Capacity Flow Rate, c (pc/h/ln)	2,200	2,200	1,900
v/c ratio	0.26	0.44	0.21
Density, D_{MD} (pc/mi/ln)	10.1	16.9	6.8
LOS	B	B	A

Formulas and Reference Material

$$f_{HV} = \frac{1}{1+P_T(E_T-1)+P_R(E_R-1)}$$ HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P}$$ HCM 2010, Equation 11-2

$$D_{MD} = \frac{0.0175*v_f}{N}$$ HCM 2010, Equation 13-26

Ramp Roadways Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

Diverge LOS Thresholds

LOS	Density (pc/mi/ln)
A	≤10
B	>10-20
C	>20-28
D	>28-35
E	>35
F	v/c > 1

Source: HCM 2010, Exhibit 13-2

RAMP ADD OR DROP LANE ANALYSIS (MAINLINE <55 MPH)

ATKINS

General Information

Date Performed:	3/20/2014	Freeway/Direction	I-26 EB C-D
Analysis Year	2018 Build-River Center Site	Junction	Remount EB On Loop
Analysis Time Period:	PM Peak	Segment ID	1050
Project Description:	Navy Base ICTF		

Inputs

	Mainline Upstream Ramp	Mainline Downstream Ramp	Ramp
Number of Lanes, N	1	1	1
Free-Flow Speed, FFS (mph)	55	55	25
Volume, V (veh/h)	844	1,243	399
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	2%	2%	2%
%RVs, P_R	0%	0%	0%

Performance Measures

	Upstream of Off-Ramp	Downstream of Off-Ramp	Off-Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.99	0.99	0.99
Demand Flow Rate, v_p (pc/h/ln)	947	1,395	448
Capacity Flow Rate, c (pc/h/ln)	2,200	2,200	1,900
v/c ratio	0.43	0.63	0.24
Density, D_{MD} (pc/mi/ln)	16.6	24.4	7.8
LOS	B	C	A

Formulas and Reference Material

$$f_{HV} = \frac{1}{1+P_T(E_T-1)+P_R(E_R-1)}$$ HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P}$$ HCM 2010, Equation 11-2

$$D_{MD} = \frac{0.0175*v_f}{N}$$ HCM 2010, Equation 13-26

Ramp Roadways Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

Diverge LOS Thresholds

LOS	Density (pc/mi/ln)
A	≤10
B	>10-20
C	>20-28
D	>28-35
E	>35
F	v/c > 1

Source: HCM 2010, Exhibit 13-2

Navy Base ICTF

FREEWAY WEAVING WORKSHEET

General Information

Analyst	AJR
Agency/Company	Atkins
Date Performed	7/25/2014
Analysis Time Period	AM Peak

Site Information

Freeway/Dir of Travel	I-26 EB
Weaving Segment Location	1060-Avi-Rem C-D to 526 C-D
Analysis Year	2018 Build - River Center Site

Project Description *Navy Base ICTF*

Inputs

Weaving configuration	One-Sided	Segment type	Freeway
Weaving number of lanes, N	5	Freeway minimum speed, S_{MIN}	15
Weaving segment length, L_S	1850ft	Freeway maximum capacity, C_{IFL}	2300
Freeway free-flow speed, FFS	60 mph	Terrain type	Level

Conversions to pc/h Under Base Conditions

	V (veh/h)	PHF	Truck (%)	RV (%)	E_T	E_R	f_{HV}	f_p	v (pc/h)
V_{FF}	4196	0.90	12	0	1.5	1.2	0.943	1.00	4942
V_{RF}	482	0.90	12	0	1.5	1.2	0.943	1.00	568
V_{FR}	3216	0.90	32	0	1.5	1.2	0.862	1.00	4145
V_{RR}	370	0.90	32	0	1.5	1.2	0.862	1.00	477
V_{NW}	5419							V =	10132
V_W	4713								
VR	0.465								

Configuration Characteristics

Minimum maneuver lanes, N_{WL}	2 lc	Minimum weaving lane changes, LC_{MIN}	lc/h
Interchange density, ID	0.7 int/mi	Weaving lane changes, LC_W	lc/h
Minimum RF lane changes, LC_{RF}	2 lc/pc	Non-weaving lane changes, LC_{NW}	lc/h
Minimum FR lane changes, LC_{FR}	0 lc/pc	Total lane changes, LC_{ALL}	lc/h
Minimum RR lane changes, LC_{RR}	lc/pc	Non-weaving vehicle index, I_{NW}	604

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment flow rate, v	10132 pc/h	Weaving intensity factor, W	
Weaving segment capacity, c_w	4867 veh/h	Weaving segment speed, S	mph
Weaving segment v/c ratio	1.964	Average weaving speed, S_W	mph
Weaving segment density, D	pc/mi/ln	Average non-weaving speed, S_{NW}	mph
Level of Service, LOS	F	Maximum weaving length, L_{MAX}	7422 ft

Notes

a. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments".
b. For volumes that exceed the weaving segment capacity, the level of service is "F".

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Navy Base ICTF

FREEWAY WEAVING WORKSHEET

General Information

Analyst	AJR
Agency/Company	Atkins
Date Performed	7/25/2014
Analysis Time Period	PM Peak

Site Information

Freeway/Dir of Travel	I-26 EB
Weaving Segment Location	1060-Avi-Rem C-D to 526 C-D
Analysis Year	2018 Build - River Center Site

Project Description *Navy Base ICTF*

Inputs

Weaving configuration	One-Sided	Segment type	Freeway
Weaving number of lanes, N	5	Freeway minimum speed, S_{MIN}	15
Weaving segment length, L_S	1850ft	Freeway maximum capacity, C_{IFL}	2300
Freeway free-flow speed, FFS	60 mph	Terrain type	Level

Conversions to pc/h Under Base Conditions

	V (veh/h)	PHF	Truck (%)	RV (%)	E_T	E_R	f_{HV}	f_p	v (pc/h)
V_{FF}	2767	0.90	10	0	1.5	1.2	0.952	1.00	3228
V_{RF}	675	0.90	10	0	1.5	1.2	0.952	1.00	788
V_{FR}	2329	0.90	34	0	1.5	1.2	0.855	1.00	3028
V_{RR}	568	0.90	34	0	1.5	1.2	0.855	1.00	738
V_{NW}	3966							V =	7782
V_W	3816								
VR	0.490								

Configuration Characteristics

Minimum maneuver lanes, N_{WL}	2 lc	Minimum weaving lane changes, LC_{MIN}	lc/h
Interchange density, ID	0.7 int/mi	Weaving lane changes, LC_W	lc/h
Minimum RF lane changes, LC_{RF}	2 lc/pc	Non-weaving lane changes, LC_{NW}	lc/h
Minimum FR lane changes, LC_{FR}	0 lc/pc	Total lane changes, LC_{ALL}	lc/h
Minimum RR lane changes, LC_{RR}	lc/pc	Non-weaving vehicle index, I_{NW}	398

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment flow rate, v	7782 pc/h	Weaving intensity factor, W	
Weaving segment capacity, c_w	4661 veh/h	Weaving segment speed, S	mph
Weaving segment v/c ratio	1.590	Average weaving speed, S_W	mph
Weaving segment density, D	pc/mi/ln	Average non-weaving speed, S_{NW}	mph
Level of Service, LOS	F	Maximum weaving length, L_{MAX}	7714 ft

Notes

a. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments".
b. For volumes that exceed the weaving segment capacity, the level of service is "F".

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-26 EB*
Agency or Company	*Atkins*	From/To	*1065 - I-526 CD Off to CD On*
Date Performed	*4/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2018 Build - River Center Site*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*4678*	veh/h	Peak-Hour Factor, PHF	*0.90*	
AADT		veh/day	%Trucks and Buses, P_T	*12*	
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*	
Peak-Hr Direction Prop, D			General Terrain:	*Level*	
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*	

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.943*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*3*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*60.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*60.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1837*	pc/h/ln
S	*59.0*	mph
D = v_p / S	*31.1*	pc/mi/ln
LOS	*D*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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F-3770

BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-26 EB*
Agency or Company	*Atkins*	From/To	*1065 - I-526 CD Off to CD On*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*PM Peak*	Analysis Year	*2018 Build - River Center Site*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*3442*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*10*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.952*

Speed Inputs			Calc Speed Adj and FFS		
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f_{LW}		mph
Number of Lanes, N	*3*		f_{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	*60.0*	mph	FFS	*60.0*	mph
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures			Design (N)	
Operational (LOS)			Design (N)	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1339*	pc/h/ln	Design LOS	
S	*60.0*	mph	v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h/ln
D = v_p / S	*22.3*	pc/mi/ln	S	mph
LOS	*C*		D = v_p / S	pc/mi/ln
			Required Number of Lanes, N	

Glossary		Factor Location	
N - Number of lanes	S - Speed	E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
V - Hourly volume	D - Density	E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 11-18	TRD - Page 11-11
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 11-2, 11-3	
DDHV - Directional design hour volume			

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RAMP ADD OR DROP LANE ANALYSIS (MAINLINE <55 MPH)

ATKINS

General Information

Date Performed:	7/25/2014	Freeway/Direction	I-26 EB C-D
Analysis Year	2018 Build-River Center Site	Junction	EB Off to I-526 WB
Analysis Time Period:	AM Peak	Segment ID	1070
Project Description:	Navy Base ICTF		

Inputs

	Mainline Upstream Ramp	Mainline Downstream Ramp	Ramp
Number of Lanes, N	2	1	1
Free-Flow Speed, FFS (mph)	55	55	45
Volume, V (veh/h)	3,586	1,365	2,221
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	32%	53%	20%
%RVs, P_R	0%	0%	0%

Performance Measures

	Upstream of Off-Ramp	Downstream of Off-Ramp	Off-Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.86	0.79	0.91
Demand Flow Rate, v_p (pc/h/ln)	2,311	1,919	2,715
Capacity Flow Rate, c (pc/h/ln)	2,200	2,200	2,100
v/c ratio	1.05	0.87	1.29
Density, D_{MD} (pc/mi/ln)	40.4	33.6	47.5
LOS	F	D	F

Formulas and Reference Material

$$f_{HV} = \frac{1}{1+P_T(E_T-1)+P_R(E_R-1)}$$ HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P}$$ HCM 2010, Equation 11-2

$$D_{MD} = \frac{0.0175*v_f}{N}$$ HCM 2010, Equation 13-26

Ramp Roadways Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

Diverge LOS Thresholds

LOS	Density (pc/mi/ln)
A	≤10
B	>10-20
C	>20-28
D	>28-35
E	>35
F	v/c > 1

Source: HCM 2010, Exhibit 13-2

RAMP ADD OR DROP LANE ANALYSIS (MAINLINE <55 MPH)

ATKINS

General Information

Date Performed:	7/25/2014	Freeway/Direction	I-26 EB C-D
Analysis Year	2018 Build-River Center Site	Junction	EB Off to I-526 WB
Analysis Time Period:	PM Peak	Segment ID	1070
Project Description:	Navy Base ICTF		

Inputs

	Mainline Upstream Ramp	Mainline Downstream Ramp	Ramp
Number of Lanes, N	2	1	1
Free-Flow Speed, FFS (mph)	55	55	45
Volume, V (veh/h)	2,897	1,116	1,781
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	34%	55%	21%
%RVs, P_R	0%	0%	0%

Performance Measures

	Upstream of Off-Ramp	Downstream of Off-Ramp	Off-Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.85	0.78	0.90
Demand Flow Rate, v_p (pc/h/ln)	1,883	1,581	2,187
Capacity Flow Rate, c (pc/h/ln)	2,200	2,200	2,100
v/c ratio	0.86	0.72	1.04
Density, D_{MD} (pc/mi/ln)	33.0	27.7	38.3
LOS	D	C	F

Formulas and Reference Material

$$f_{HV} = \frac{1}{1+P_T(E_T-1)+P_R(E_R-1)}$$ HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P}$$ HCM 2010, Equation 11-2

$$D_{MD} = \frac{0.0175*v_f}{N}$$ HCM 2010, Equation 13-26

Ramp Roadways Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

Diverge LOS Thresholds

LOS	Density (pc/mi/ln)
A	≤10
B	>10-20
C	>20-28
D	>28-35
E	>35
F	v/c > 1

Source: HCM 2010, Exhibit 13-2

BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-26 EB C-D*
Agency or Company	*Atkins*	From/To	*1075-I526 WB Off to I526 WB On*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2018 Build - River Center Site*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*2730*	veh/h	Peak-Hour Factor, PHF	*0.90*	
AADT		veh/day	%Trucks and Buses, P_T	*53*	
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*	
Peak-Hr Direction Prop, D			General Terrain:	*Level*	
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*	

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.791*

Speed Inputs			Calc Speed Adj and FFS		
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f_{LW}		mph
Number of Lanes, N	*2*		f_{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	*55.0*	mph	FFS	*55.0*	mph
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures			Design (N)	
Operational (LOS)			Design (N)	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1919*	pc/h/ln	Design LOS	
S	*54.7*	mph	v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h/ln
D = v_p / S	*35.1*	pc/mi/ln	S	mph
LOS	*E*		D = v_p / S	pc/mi/ln
			Required Number of Lanes, N	

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-26 EB C-D*
Agency or Company	*Atkins*	From/To	*1075-I526 WB Off to I526 WB On*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*PM Peak*	Analysis Year	*2018 Build - River Center Site*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*2232*	veh/h	Peak-Hour Factor, PHF	*0.90*	
AADT		veh/day	%Trucks and Buses, P_T	*55*	
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*	
Peak-Hr Direction Prop, D			General Terrain:	*Level*	
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*	

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.784*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*55.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*55.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1581*	pc/h/ln
S	*55.0*	mph
D = v_p / S	*28.7*	pc/mi/ln
LOS	*D*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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Navy Base ICTF

FREEWAY WEAVING WORKSHEET

General Information

Analyst	AJR
Agency/Company	Atkins
Date Performed	3/20/2014
Analysis Time Period	AM Peak

Site Information

Freeway/Dir of Travel	I-26 EB C-D
Weaving Segment Location	1080 - I-526 WB to I-526 EB
Analysis Year	2018 Build - River Center Site

Project Description *Navy Base ICTF*

Inputs

Weaving configuration	One-Sided	Segment type	C-D Roadway/ Multilane Highways
Weaving number of lanes, N	2	Freeway minimum speed, S_{MIN}	15
Weaving segment length, L_S	620ft	Freeway maximum capacity, C_{IFL}	2250
Freeway free-flow speed, FFS	55 mph	Terrain type	Level

Conversions to pc/h Under Base Conditions

	V (veh/h)	PHF	Truck (%)	RV (%)	E_T	E_R	f_{HV}	f_p	v (pc/h)
V_{FF}	0	0.90	0	0	1.5	1.2	1.000	1.00	0
V_{RF}	547	0.90	8	0	1.5	1.2	0.962	1.00	632
V_{FR}	1365	0.90	53	0	1.5	1.2	0.791	1.00	1919
V_{RR}	0	0.90	0	0	1.5	1.2	1.000	1.00	0
V_{NW}	0							V =	2551
V_W	2551								
VR	1.000								

Configuration Characteristics

Minimum maneuver lanes, N_{WL}	2 lc	Minimum weaving lane changes, LC_{MIN}	lc/h
Interchange density, ID	0.8 int/mi	Weaving lane changes, LC_W	lc/h
Minimum RF lane changes, LC_{RF}	1 lc/pc	Non-weaving lane changes, LC_{NW}	lc/h
Minimum FR lane changes, LC_{FR}	1 lc/pc	Total lane changes, LC_{ALL}	lc/h
Minimum RR lane changes, LC_{RR}	lc/pc	Non-weaving vehicle index, I_{NW}	0

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment flow rate, v	2551 pc/h	Weaving intensity factor, W	
Weaving segment capacity, c_w	2400 veh/h	Weaving segment speed, S	mph
Weaving segment v/c ratio	1.063	Average weaving speed, S_W	mph
Weaving segment density, D	pc/mi/ln	Average non-weaving speed, S_{NW}	mph
Level of Service, LOS	F	Maximum weaving length, L_{MAX}	14232 ft

Notes

a. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments".
b. For volumes that exceed the weaving segment capacity, the level of service is "F".

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Navy Base ICTF

FREEWAY WEAVING WORKSHEET

General Information

Analyst	AJR
Agency/Company	Atkins
Date Performed	7/25/2014
Analysis Time Period	PM Peak

Site Information

Freeway/Dir of Travel	I-26 EB C-D
Weaving Segment Location	1080 - I-526 WB to I-526 EB
Analysis Year	2018 Build - River Center Site

Project Description *Navy Base ICTF*

Inputs

Weaving configuration	One-Sided	Segment type	C-D Roadway/ Multilane Highways
Weaving number of lanes, N	2	Freeway minimum speed, S_{MIN}	15
Weaving segment length, L_S	620ft	Freeway maximum capacity, C_{IFL}	2250
Freeway free-flow speed, FFS	55 mph	Terrain type	Level

Conversions to pc/h Under Base Conditions

	V (veh/h)	PHF	Truck (%)	RV (%)	E_T	E_R	f_{HV}	f_p	v (pc/h)
V_{FF}	0	0.90	0	0	1.5	1.2	1.000	1.00	0
V_{RF}	482	0.90	8	0	1.5	1.2	0.962	1.00	557
V_{FR}	1116	0.90	55	0	1.5	1.2	0.784	1.00	1581
V_{RR}	0	0.90	0	0	1.5	1.2	1.000	1.00	0
V_{NW}	0							V =	2138
V_W	2138								
VR	1.000								

Configuration Characteristics

Minimum maneuver lanes, N_{WL}	2 lc	Minimum weaving lane changes, LC_{MIN}	2138 lc/h
Interchange density, ID	0.8 int/mi	Weaving lane changes, LC_W	2183 lc/h
Minimum RF lane changes, LC_{RF}	1 lc/pc	Non-weaving lane changes, LC_{NW}	0 lc/h
Minimum FR lane changes, LC_{FR}	1 lc/pc	Total lane changes, LC_{ALL}	2183 lc/h
Minimum RR lane changes, LC_{RR}	lc/pc	Non-weaving vehicle index, I_{NW}	0

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment flow rate, v	2138 pc/h	Weaving intensity factor, W	0.610
Weaving segment capacity, c_w	2400 veh/h	Weaving segment speed, S	39.8 mph
Weaving segment v/c ratio	0.891	Average weaving speed, S_W	39.8 mph
Weaving segment density, D	26.8 pc/mi/ln	Average non-weaving speed, S_{NW}	34.5 mph
Level of Service, LOS	C	Maximum weaving length, L_{MAX}	14232 ft

Notes

a. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments".
b. For volumes that exceed the weaving segment capacity, the level of service is "F".

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-26 EB C-D*
Agency or Company	*Atkins*	From/To	*1085-I526 EB Off to I526 EB On*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2018 Build - River Center Site*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*1094*	veh/h	Peak-Hour Factor, PHF	*0.90*	
AADT		veh/day	%Trucks and Buses, P_T	*8*	
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*	
Peak-Hr Direction Prop, D			General Terrain:	*Level*	
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*	

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.962*

Speed Inputs			Calc Speed Adj and FFS		
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f_{LW}		mph
Number of Lanes, N	*2*		f_{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	*55.0*	mph	FFS	*55.0*	mph
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures			Design (N)		
Operational (LOS)			Design (N)		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*632*	pc/h/ln	Design LOS		
S	*55.0*	mph	v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
D = v_p / S	*11.5*	pc/mi/ln	S		mph
LOS	*B*		D = v_p / S		pc/mi/ln
			Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-26 EB C-D*
Agency or Company	*Atkins*	From/To	*1085-I526 EB Off to I526 EB On*
Date Performed	*4/25/2014*	Jurisdiction	
Analysis Time Period	*PM Peak*	Analysis Year	*2018 Build - River Center Site*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*964*	veh/h	Peak-Hour Factor, PHF	*0.90*	
AADT		veh/day	%Trucks and Buses, P_T	*8*	
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*	
Peak-Hr Direction Prop, D			General Terrain:	*Level*	
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*	

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.962*

Speed Inputs			Calc Speed Adj and FFS		
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f_{LW}		mph
Number of Lanes, N	*2*		f_{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	*55.0*	mph	FFS	*55.0*	mph
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures			Design (N)		
Operational (LOS)			Design (N)		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*557*	pc/h/ln	Design LOS		
S	*55.0*	mph	v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
D = v_p / S	*10.1*	pc/mi/ln	S		mph
LOS	*A*		D = v_p / S		pc/mi/ln
			Required Number of Lanes, N		

Glossary		Factor Location	
N - Number of lanes	S - Speed	E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
V - Hourly volume	D - Density	E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 11-18	TRD - Page 11-11
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 11-2, 11-3	
DDHV - Directional design hour volume			

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RAMP ADD OR DROP LANE ANALYSIS (MAINLINE <55 MPH)

ATKINS

General Information

Date Performed:	7/25/2014	Freeway/Direction	I-26 EB
Analysis Year	2018 Build-River Center Site	Junction	I-526 EB Ramp Split
Analysis Time Period:	AM Peak	Segment ID	1088
Project Description:	Navy Base ICTF		

Inputs

	Mainline Upstream Ramp	Mainline Downstream Ramp	Ramp
Number of Lanes, N	2	2	1
Free-Flow Speed, FFS (mph)	55	55	55
Volume, V (veh/h)	2,099	1,800	299
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	11%	13%	3%
%RVs, P_R	0%	0%	0%

Performance Measures

	Upstream of Off-Ramp	Downstream of Off-Ramp	Off-Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.95	0.94	0.99
Demand Flow Rate, v_p (pc/h/ln)	1,230	1,065	337
Capacity Flow Rate, c (pc/h/ln)	2,200	2,200	2,200
v/c ratio	0.56	0.48	0.15
Density, D_{MD} (pc/mi/ln)	21.5	18.6	5.9
LOS	C	B	A

Formulas and Reference Material

$$f_{HV} = \frac{1}{1+P_T(E_T-1)+P_R(E_R-1)}$$ HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P}$$ HCM 2010, Equation 11-2

$$D_{MD} = \frac{0.0175*v_f}{N}$$ HCM 2010, Equation 13-26

Ramp Roadways Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

Diverge LOS Thresholds

LOS	Density (pc/mi/ln)
A	≤10
B	>10-20
C	>20-28
D	>28-35
E	>35
F	v/c > 1

Source: HCM 2010, Exhibit 13-2

RAMP ADD OR DROP LANE ANALYSIS (MAINLINE <55 MPH)

ATKINS

General Information

Date Performed:	3/20/2014	Freeway/Direction	I-26 EB
Analysis Year	2018 Build-River Center Site	Junction	I-526 EB Ramp Split
Analysis Time Period:	PM Peak	Segment ID	1088
Project Description:	Navy Base ICTF		

Inputs

	Mainline Upstream Ramp	Mainline Downstream Ramp	Ramp
Number of Lanes, N	2	2	1
Free-Flow Speed, FFS (mph)	55	55	55
Volume, V (veh/h)	2,426	2,082	344
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	9%	10%	3%
%RVs, P_R	0%	0%	0%

Performance Measures

	Upstream of Off-Ramp	Downstream of Off-Ramp	Off-Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.96	0.95	0.99
Demand Flow Rate, v_p (pc/h/ln)	1,408	1,215	388
Capacity Flow Rate, c (pc/h/ln)	2,200	2,200	2,200
v/c ratio	0.64	0.55	0.18
Density, D_{MD} (pc/mi/ln)	24.6	21.3	6.8
LOS	C	C	A

Formulas and Reference Material

$$f_{HV} = \frac{1}{1+P_T(E_T-1)+P_R(E_R-1)}$$ HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P}$$ HCM 2010, Equation 11-2

$$D_{MD} = \frac{0.0175*v_f}{N}$$ HCM 2010, Equation 13-26

Ramp Roadways Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

Diverge LOS Thresholds

LOS	Density (pc/mi/ln)
A	≤10
B	>10-20
C	>20-28
D	>28-35
E	>35
F	v/c > 1

Source: HCM 2010, Exhibit 13-2

RAMP ADD OR DROP LANE ANALYSIS (MAINLINE <55 MPH)

ATKINS

General Information

Date Performed:	3/20/2014	Freeway/Direction	I-26 EB C-D
Analysis Year	2018 Build-River Center Site	Junction	I-526 EB On
Analysis Time Period:	AM Peak	Segment ID	1090
Project Description:	Navy Base ICTF		

Inputs

	Mainline Upstream Ramp	Mainline Downstream Ramp	Ramp
Number of Lanes, N	1	1	1
Free-Flow Speed, FFS (mph)	55	55	45
Volume, V (veh/h)	547	846	299
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	8%	7%	3%
%RVs, P_R	0%	0%	0%

Performance Measures

	Upstream of Off-Ramp	Downstream of Off-Ramp	Off-Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.96	0.97	0.99
Demand Flow Rate, v_p (pc/h/ln)	632	973	337
Capacity Flow Rate, c (pc/h/ln)	2,200	2,200	2,100
v/c ratio	0.29	0.44	0.16
Density, D_{MD} (pc/mi/ln)	11.1	17.0	5.9
LOS	B	B	A

Formulas and Reference Material

$$f_{HV} = \frac{1}{1+P_T(E_T-1)+P_R(E_R-1)}$$ HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P}$$ HCM 2010, Equation 11-2

$$D_{MD} = \frac{0.0175*v_f}{N}$$ HCM 2010, Equation 13-26

Ramp Roadways Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

Diverge LOS Thresholds

LOS	Density (pc/mi/ln)
A	≤10
B	>10-20
C	>20-28
D	>28-35
E	>35
F	v/c > 1

Source: HCM 2010, Exhibit 13-2

RAMP ADD OR DROP LANE ANALYSIS (MAINLINE <55 MPH)

ATKINS

General Information

Date Performed:	7/25/2014	Freeway/Direction	I-26 EB C-D
Analysis Year	2018 Build-River Center Site	Junction	I-526 EB On
Analysis Time Period:	PM Peak	Segment ID	1090
Project Description:	Navy Base ICTF		

Inputs

	Mainline Upstream Ramp	Mainline Downstream Ramp	Ramp
Number of Lanes, N	1	1	1
Free-Flow Speed, FFS (mph)	55	55	45
Volume, V (veh/h)	482	826	344
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	8%	6%	3%
%RVs, P_R	0%	0%	0%

Performance Measures

	Upstream of Off-Ramp	Downstream of Off-Ramp	Off-Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.96	0.97	0.99
Demand Flow Rate, v_p (pc/h/ln)	557	945	388
Capacity Flow Rate, c (pc/h/ln)	2,200	2,200	2,100
v/c ratio	0.25	0.43	0.18
Density, D_{MD} (pc/mi/ln)	9.7	16.5	6.8
LOS	A	B	A

Formulas and Reference Material

$$f_{HV} = \frac{1}{1+P_T(E_T-1)+P_R(E_R-1)}$$ HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P}$$ HCM 2010, Equation 11-2

$$D_{MD} = \frac{0.0175*v_f}{N}$$ HCM 2010, Equation 13-26

Ramp Roadways Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

Diverge LOS Thresholds

LOS	Density (pc/mi/ln)
A	≤10
B	>10-20
C	>20-28
D	>28-35
E	>35
F	v/c > 1

Source: HCM 2010, Exhibit 13-2

Navy Base ICTF

FREEWAY WEAVING WORKSHEET

General Information

Analyst	AJR
Agency/Company	Atkins
Date Performed	7/25/2014
Analysis Time Period	AM Peak

Site Information

Freeway/Dir of Travel	I-26 EB
Weaving Segment Location	1100 - I-526 CD to Montague SB
Analysis Year	2018 Build - River Center Site

Project Description *Navy Base ICTF*

Inputs

Weaving configuration	One-Sided
Weaving number of lanes, N	4
Weaving segment length, L_S	1550ft
Freeway free-flow speed, FFS	60 mph
Segment type	Freeway
Freeway minimum speed, S_{MIN}	15
Freeway maximum capacity, C_{IFL}	2300
Terrain type	Level

Conversions to pc/h Under Base Conditions

	V (veh/h)	PHF	Truck (%)	RV (%)	E_T	E_R	f_{HV}	fp	v (pc/h)
V_{FF}	4119	0.90	4	0	1.5	1.2	0.980	1.00	4668
V_{RF}	745	0.90	7	0	1.5	1.2	0.966	1.00	857
V_{FR}	559	0.90	14	0	1.5	1.2	0.935	1.00	665
V_{RR}	101	0.90	14	0	1.5	1.2	0.935	1.00	120
V_{NW}	4788							V =	6310
V_W	1522								
VR	0.241								

Configuration Characteristics

Minimum maneuver lanes, N_{WL}	2 lc	Minimum weaving lane changes, LC_{MIN}	1522 lc/h
Interchange density, ID	0.8 int/mi	Weaving lane changes, LC_W	1875 lc/h
Minimum RF lane changes, LC_{RF}	1 lc/pc	Non-weaving lane changes, LC_{NW}	1056 lc/h
Minimum FR lane changes, LC_{FR}	1 lc/pc	Total lane changes, LC_{ALL}	2931 lc/h
Minimum RR lane changes, LC_{RR}	lc/pc	Non-weaving vehicle index, I_{NW}	594

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment flow rate, v	6310 pc/h	Weaving intensity factor, W	0.374
Weaving segment capacity, c_w	7996 veh/h	Weaving segment speed, S	42.8 mph
Weaving segment v/c ratio	0.774	Average weaving speed, S_W	47.8 mph
Weaving segment density, D	36.8 pc/mi/ln	Average non-weaving speed, S_{NW}	41.5 mph
Level of Service, LOS	E	Maximum weaving length, L_{MAX}	4962 ft

Notes

a. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments".
b. For volumes that exceed the weaving segment capacity, the level of service is "F".

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Navy Base ICTF

FREEWAY WEAVING WORKSHEET

General Information

Analyst	AJR
Agency/Company	Atkins
Date Performed	3/20/2014
Analysis Time Period	PM Peak

Site Information

Freeway/Dir of Travel	I-26 EB
Weaving Segment Location	1100 - I-526 CD to Montague SB
Analysis Year	2018 Build - River Center Site

Project Description *Navy Base ICTF*

Inputs

Weaving configuration	One-Sided
Weaving number of lanes, N	4
Weaving segment length, L_S	1550ft
Freeway free-flow speed, FFS	60 mph
Segment type	Freeway
Freeway minimum speed, S_{MIN}	15
Freeway maximum capacity, C_{IFL}	2300
Terrain type	Level

Conversions to pc/h Under Base Conditions

	V (veh/h)	PHF	Truck (%)	RV (%)	E_T	E_R	f_{HV}	f_p	v (pc/h)
V_{FF}	2624	0.90	3	0	1.5	1.2	0.985	1.00	2959
V_{RF}	630	0.90	6	0	1.5	1.2	0.971	1.00	721
V_{FR}	818	0.90	8	0	1.5	1.2	0.962	1.00	945
V_{RR}	196	0.90	8	0	1.5	1.2	0.962	1.00	226
V_{NW}	3185							V =	4851
V_W	1666								
VR	0.343								

Configuration Characteristics

Minimum maneuver lanes, N_{WL}	2 lc	Minimum weaving lane changes, LC_{MIN}	1666 lc/h
Interchange density, ID	0.8 int/mi	Weaving lane changes, LC_W	2019 lc/h
Minimum RF lane changes, LC_{RF}	1 lc/pc	Non-weaving lane changes, LC_{NW}	726 lc/h
Minimum FR lane changes, LC_{FR}	1 lc/pc	Total lane changes, LC_{ALL}	2745 lc/h
Minimum RR lane changes, LC_{RR}	lc/pc	Non-weaving vehicle index, I_{NW}	395

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment flow rate, v	4851 pc/h	Weaving intensity factor, W	0.355
Weaving segment capacity, c_w	6885 veh/h	Weaving segment speed, S	44.1 mph
Weaving segment v/c ratio	0.694	Average weaving speed, S_W	48.2 mph
Weaving segment density, D	27.5 pc/mi/ln	Average non-weaving speed, S_{NW}	42.2 mph
Level of Service, LOS	C	Maximum weaving length, L_{MAX}	6054 ft

Notes

a. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments".
b. For volumes that exceed the weaving segment capacity, the level of service is "F".

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-26 EB*
Agency or Company	*Atkins*	From/To	*1105-Mont SB Off to Mont SB On*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2018 Build - River Center Site*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*4864*	veh/h	Peak-Hour Factor, PHF	*0.90*	
AADT		veh/day	%Trucks and Buses, P_T	*4*	
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*	
Peak-Hr Direction Prop, D			General Terrain:	*Level*	
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*	

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.980*

Speed Inputs			Calc Speed Adj and FFS		
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f_{LW}		mph
Number of Lanes, N	*3*		f_{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	*60.0*	mph	FFS	*60.0*	mph
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures			Design (N)	
Operational (LOS)			Design (N)	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1838*	pc/h/ln	Design LOS	
			v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h/ln
S	*59.0*	mph	S	mph
D = v_p / S	*31.2*	pc/mi/ln	D = v_p / S	pc/mi/ln
LOS	*D*		Required Number of Lanes, N	

Glossary		Factor Location	
N - Number of lanes	S - Speed	E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
V - Hourly volume	D - Density	E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 11-18	TRD - Page 11-11
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 11-2, 11-3	
DDHV - Directional design hour volume			

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-26 EB*
Agency or Company	*Atkins*	From/To	*1105-Mont SB Off to Mont SB On*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*PM Peak*	Analysis Year	*2018 Build - River Center Site*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*3254*	veh/h	Peak-Hour Factor, PHF	*0.90*	
AADT		veh/day	%Trucks and Buses, P_T	*3*	
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*	
Peak-Hr Direction Prop, D			General Terrain:	*Level*	
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*	

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.985*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*3*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*60.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*60.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1223*	pc/h/ln
S	*60.0*	mph
D = v_p / S	*20.4*	pc/mi/ln
LOS	*C*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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F-3787

Navy Base ICTF

FREEWAY WEAVING WORKSHEET

General Information

Analyst	AJR
Agency/Company	Atkins
Date Performed	7/25/2014
Analysis Time Period	AM Peak

Site Information

Freeway/Dir of Travel	I-26 EB
Weaving Segment Location	1110 - Montague SB to Mont. NB
Analysis Year	2018 Build - River Center Site

Project Description *Navy Base ICTF*

Inputs

Weaving configuration	One-Sided
Weaving number of lanes, N	4
Weaving segment length, L_S	470ft
Freeway free-flow speed, FFS	60 mph
Segment type	Freeway
Freeway minimum speed, S_{MIN}	15
Freeway maximum capacity, C_{IFL}	2300
Terrain type	Level

Conversions to pc/h Under Base Conditions

	V (veh/h)	PHF	Truck (%)	RV (%)	E_T	E_R	f_{HV}	fp	v (pc/h)
V_{FF}	4407	0.90	4	0	1.5	1.2	0.980	1.00	4995
V_{RF}	366	0.90	9	0	1.5	1.2	0.957	1.00	425
V_{FR}	457	0.90	5	0	1.5	1.2	0.976	1.00	520
V_{RR}	0	0.90	0	0	1.5	1.2	1.000	1.00	0
V_{NW}	4995							V =	5940
V_W	945								
VR	0.159								

Configuration Characteristics

Minimum maneuver lanes, N_{WL}	2 lc	Minimum weaving lane changes, LC_{MIN}	945 lc/h
Interchange density, ID	1.0 int/mi	Weaving lane changes, LC_W	1087 lc/h
Minimum RF lane changes, LC_{RF}	1 lc/pc	Non-weaving lane changes, LC_{NW}	513 lc/h
Minimum FR lane changes, LC_{FR}	1 lc/pc	Total lane changes, LC_{ALL}	1600 lc/h
Minimum RR lane changes, LC_{RR}	lc/pc	Non-weaving vehicle index, I_{NW}	235

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment flow rate, v	5940 pc/h	Weaving intensity factor, W	0.594
Weaving segment capacity, c_w	7925 veh/h	Weaving segment speed, S	45.6 mph
Weaving segment v/c ratio	0.735	Average weaving speed, S_W	43.2 mph
Weaving segment density, D	32.6 pc/mi/ln	Average non-weaving speed, S_{NW}	46.1 mph
Level of Service, LOS	D	Maximum weaving length, L_{MAX}	4122 ft

Notes

a. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments".
b. For volumes that exceed the weaving segment capacity, the level of service is "F".

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F-3788

Navy Base ICTF

FREEWAY WEAVING WORKSHEET

General Information

Analyst	AJR
Agency/Company	Atkins
Date Performed	7/25/2014
Analysis Time Period	PM Peak

Site Information

Freeway/Dir of Travel	I-26 EB
Weaving Segment Location	1110 - Montague SB to Mont. NB
Analysis Year	2018 Build - River Center Site

Project Description *Navy Base ICTF*

Inputs

Weaving configuration	One-Sided
Weaving number of lanes, N	4
Weaving segment length, L_S	470ft
Freeway free-flow speed, FFS	60 mph
Segment type	Freeway
Freeway minimum speed, S_{MIN}	15
Freeway maximum capacity, C_{IFL}	2300
Terrain type	Level

Conversions to pc/h Under Base Conditions

	V (veh/h)	PHF	Truck (%)	RV (%)	E_T	E_R	f_{HV}	fp	v (pc/h)
V_{FF}	3008	0.90	3	0	1.5	1.2	0.985	1.00	3392
V_{RF}	463	0.90	6	0	1.5	1.2	0.971	1.00	530
V_{FR}	246	0.90	9	0	1.5	1.2	0.957	1.00	286
V_{RR}	0	0.90	0	0	1.5	1.2	1.000	1.00	0
V_{NW}	3392							V =	4208
V_W	816								
VR	0.194								

Configuration Characteristics

Minimum maneuver lanes, N_{WL}	2 lc	Minimum weaving lane changes, LC_{MIN}	816 lc/h
Interchange density, ID	1.0 int/mi	Weaving lane changes, LC_W	958 lc/h
Minimum RF lane changes, LC_{RF}	1 lc/pc	Non-weaving lane changes, LC_{NW}	183 lc/h
Minimum FR lane changes, LC_{FR}	1 lc/pc	Total lane changes, LC_{ALL}	1141 lc/h
Minimum RR lane changes, LC_{RR}	lc/pc	Non-weaving vehicle index, I_{NW}	159

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment flow rate, v	4208 pc/h	Weaving intensity factor, W	0.455
Weaving segment capacity, c_w	7858 veh/h	Weaving segment speed, S	48.4 mph
Weaving segment v/c ratio	0.528	Average weaving speed, S_W	45.9 mph
Weaving segment density, D	21.7 pc/mi/ln	Average non-weaving speed, S_{NW}	49.1 mph
Level of Service, LOS	C	Maximum weaving length, L_{MAX}	4474 ft

Notes

a. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments".
b. For volumes that exceed the weaving segment capacity, the level of service is "F".

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-26 EB*
Agency or Company	*Atkins*	From/To	*1115-Mont NB Off to Mont NB On*
Date Performed	*4/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2018 Build - River Center Site*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*4773*	veh/h	Peak-Hour Factor, PHF	*0.90*	
AADT		veh/day	%Trucks and Buses, P_T	*4*	
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*	
Peak-Hr Direction Prop, D			General Terrain:	*Level*	
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*	

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.980*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*3*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*60.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*60.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1803*	pc/h/ln
S	*59.3*	mph
D = v_p / S	*30.4*	pc/mi/ln
LOS	*D*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-26 EB*
Agency or Company	*Atkins*	From/To	*1115-Mont NB Off to Mont NB On*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*PM Peak*	Analysis Year	*2018 Build - River Center Site*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*3471*	veh/h	Peak-Hour Factor, PHF	*0.90*	
AADT		veh/day	%Trucks and Buses, P_T	*3*	
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*	
Peak-Hr Direction Prop, D			General Terrain:	*Level*	
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*	

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.985*

Speed Inputs			Calc Speed Adj and FFS		
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f_{LW}		mph
Number of Lanes, N	*3*		f_{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	*60.0*	mph	FFS	*60.0*	mph
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures			Design (N)		
Operational (LOS)			Design (N)		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1305*	pc/h/ln	Design LOS		
S	*60.0*	mph	v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
D = v_p / S	*21.8*	pc/mi/ln	S		mph
LOS	*C*		D = v_p / S		pc/mi/ln
			Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-26 EB
Agency or Company	Atkins	Junction	1120 - EB On from Montague NB
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2018 Build - River Center Site

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Freeway Number of Lanes, N	3	Downstream Adj Ramp	
☐ Yes	☐ On	Ramp Number of Lanes, N	1	☐ Yes	☐ On
☑ No	☐ Off	Acceleration Lane Length, L_A	850	☑ No	☐ Off
L_{up} =	ft	Deceleration Lane Length L_D		L_{down} =	ft
V_u =	veh/h	Freeway Volume, V_F	4773	V_D =	veh/h
		Ramp Volume, V_R	537		
		Freeway Free-Flow Speed, S_{FF}	60.0		
		Ramp Free-Flow Speed, S_{FR}	45.0		

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	4773	0.90	Level	4	0	0.980	1.00	5409
Ramp	537	0.90	Level	5	0	0.976	1.00	612
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 0.601 using Equation (Exhibit 13-6)

V_{12} = 3252 pc/h

V_3 or V_{av34} 2157 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * $V_{12}/2$ ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	6021	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	3864	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = 30.0 (pc/mi/ln)

LOS = D (Exhibit 13-2)

Speed Determination

M_S = 0.430 (Exibit 13-11)

S_R= 52.3 mph (Exhibit 13-11)

S_0= 54.0 mph (Exhibit 13-11)

S = 52.9 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * $V_{12}/2$ ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-26 EB
Agency or Company	Atkins	Junction	1120 - EB On from Montague NB
Date Performed	4/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2018 Build - River Center Site

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Freeway Number of Lanes, N: 3	☐ Yes ☐ On
☑ No ☐ Off	Ramp Number of Lanes, N: 1	☑ No ☐ Off
L_{up} = ft	Acceleration Lane Length, L_A: 850	L_{down} = ft
V_u = veh/h	Deceleration Lane Length L_D:	V_D = veh/h
	Freeway Volume, V_F: 3471	
	Ramp Volume, V_R: 582	
	Freeway Free-Flow Speed, S_{FF}: 60.0	
	Ramp Free-Flow Speed, S_{FR}: 45.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	3471	0.90	Level	3	0	0.985	1.00	3915
Ramp	582	0.90	Level	4	0	0.980	1.00	660
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 0.601 using Equation (Exhibit 13-6)

V_{12} = 2354 pc/h

V_3 or V_{av34} 1561 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * $V_{12}/2$ ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	4575	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	3014	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = 23.4 (pc/mi/ln)

LOS = C (Exhibit 13-2)

Speed Determination

M_S = 0.324 (Exibit 13-11)

S_R= 54.2 mph (Exhibit 13-11)

S_0= 56.2 mph (Exhibit 13-11)

S = 54.8 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * $V_{12}/2$ ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-26 EB*
Agency or Company	*Atkins*	From/To	*1130 - Montague to Dorchester*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2018 Build - River Center Site*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*5310*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*3*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.985*

Speed Inputs			Calc Speed Adj and FFS		
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f_{LW}		mph
Number of Lanes, N	*3*		f_{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	*60.0*	mph	FFS	*60.0*	mph
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures			Design (N)	
Operational (LOS)			Design (N)	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1996*	pc/h/ln	Design LOS	
			v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h/ln
S	*57.2*	mph	S	mph
D = v_p / S	*34.9*	pc/mi/ln	D = v_p / S	pc/mi/ln
LOS	*D*		Required Number of Lanes, N	

Glossary		Factor Location	
N - Number of lanes	S - Speed	E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
V - Hourly volume	D - Density	E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 11-18	TRD - Page 11-11
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 11-2, 11-3	
DDHV - Directional design hour volume			

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-26 EB*
Agency or Company	*Atkins*	From/To	*1130 - Montague to Dorchester*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*PM Peak*	Analysis Year	*2018 Build - River Center Site*
Project Description	*Navy Base ICTF*		

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*4053*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*3*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.985*

Speed Inputs			Calc Speed Adj and FFS		
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f_{LW}		mph
Number of Lanes, N	*3*		f_{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	*60.0*	mph	FFS	*60.0*	mph
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures			Design (N)	
Operational (LOS)			Design (N)	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1524*	pc/h/ln	Design LOS	
S	*60.0*	mph	v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h/ln
D = v_p / S	*25.4*	pc/mi/ln	S	mph
LOS	*C*		D = v_p / S	pc/mi/ln
			Required Number of Lanes, N	

Glossary		Factor Location	
N - Number of lanes	S - Speed	E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
V - Hourly volume	D - Density	E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 11-18	TRD - Page 11-11
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 11-2, 11-3	
DDHV - Directional design hour volume			

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-26 EB
Agency or Company	Atkins	Junction	1140-EB Off to Dorchester Rd
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2018 Build - River Center Site

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Freeway Number of Lanes, N	3	Downstream Adj Ramp	
☐ Yes	☐ On	Ramp Number of Lanes, N	1	☐ Yes	☐ On
☑ No	☐ Off	Acceleration Lane Length, L_A		☑ No	☐ Off
L_{up} =	ft	Deceleration Lane Length L_D	380	L_{down} =	ft
V_u =	veh/h	Freeway Volume, V_F	5310	V_D =	veh/h
		Ramp Volume, V_R	550		
		Freeway Free-Flow Speed, S_{FF}	60.0		
		Ramp Free-Flow Speed, S_{FR}	45.0		

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	5310	0.90	Level	3	0	0.985	1.00	5989
Ramp	550	0.90	Level	12	0	0.943	1.00	648
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 0.580 using Equation (Exhibit 13-7)

V_{12} = 3748 pc/h

V_3 or V_{av34} 2241 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	5989	Exhibit 13-8	6900	No
$V_{FO} = V_F - V_R$	5341	Exhibit 13-8	6900	No
V_R	648	Exhibit 13-10	2100	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	3748	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = 33.1 (pc/mi/ln)

LOS = D (Exhibit 13-2)

Speed Determination

D_s = 0.356 (Exhibit 13-12)

S_R= 53.6 mph (Exhibit 13-12)

S_0= 61.0 mph (Exhibit 13-12)

S = 56.1 mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-26 EB
Agency or Company	Atkins	Junction	1140-EB Off to Dorchester Rd
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2018 Build - River Center Site

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Freeway Number of Lanes, N: 3	☐ Yes ☐ On
☑ No ☐ Off	Ramp Number of Lanes, N: 1	☑ No ☐ Off
L_{up} = ft	Acceleration Lane Length, L_A	L_{down} = ft
V_u = veh/h	Deceleration Lane Length L_D: 380	V_D = veh/h
	Freeway Volume, V_F: 4053	
	Ramp Volume, V_R: 377	
	Freeway Free-Flow Speed, S_{FF}: 60.0	
	Ramp Free-Flow Speed, S_{FR}: 45.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	4053	0.90	Level	3	0	0.985	1.00	4571
Ramp	377	0.90	Level	15	0	0.930	1.00	450
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 0.625 using Equation (Exhibit 13-7)

V_{12} = 3026 pc/h

V_3 or V_{av34} 1545 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	4571	Exhibit 13-8	6900	No
$V_{FO} = V_F - V_R$	4121	Exhibit 13-8	6900	No
V_R	450	Exhibit 13-10	2100	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	3026	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = 26.9 (pc/mi/ln)

LOS = C (Exhibit 13-2)

Speed Determination

D_s = 0.338 (Exhibit 13-12)

S_R= 53.9 mph (Exhibit 13-12)

S_0= 63.7 mph (Exhibit 13-12)

S = 56.9 mph (Exhibit 13-13)

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-26 EB*
Agency or Company	*Atkins*	From/To	*1145-Dorches Off to Dorches On*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2018 Build - River Center Site*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*4760*	veh/h	Peak-Hour Factor, PHF	*0.90*	
AADT		veh/day	%Trucks and Buses, P_T	*4*	
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*	
Peak-Hr Direction Prop, D			General Terrain:	*Level*	
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*	

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.980*

Speed Inputs			Calc Speed Adj and FFS		
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f_{LW}		mph
Number of Lanes, N	*3*		f_{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	*60.0*	mph	FFS	*60.0*	mph
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures			Design (N)	
Operational (LOS)			Design (N)	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1798*	pc/h/ln	Design LOS	
S	*59.3*	mph	v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h/ln
D = v_p / S	*30.3*	pc/mi/ln	S	mph
LOS	*D*		D = v_p / S	pc/mi/ln
			Required Number of Lanes, N	

Glossary		Factor Location	
N - Number of lanes	S - Speed	E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
V - Hourly volume	D - Density	E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 11-18	TRD - Page 11-11
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 11-2, 11-3	
DDHV - Directional design hour volume			

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-26 EB*
Agency or Company	*Atkins*	From/To	*1145-Dorches Off to Dorches On*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*PM Peak*	Analysis Year	*2018 Build - River Center Site*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*3676*	veh/h	Peak-Hour Factor, PHF	*0.90*	
AADT		veh/day	%Trucks and Buses, P_T	*3*	
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*	
Peak-Hr Direction Prop, D			General Terrain:	*Level*	
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*	

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.985*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*3*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*60.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*60.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1382*	pc/h/ln
S	*60.0*	mph
D = v_p / S	*23.0*	pc/mi/ln
LOS	*C*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-26 EB
Agency or Company	Atkins	Junction	1150 - EB On from Dorchester
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2018 Build - River Center Site

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Freeway Number of Lanes, N: 3	☑ Yes ☐ On
☑ No ☐ Off	Ramp Number of Lanes, N: 1	☐ No ☑ Off
L_{up} = ft	Acceleration Lane Length, L_A: 560	L_{down} = 2100 ft
V_u = veh/h	Deceleration Lane Length L_D:	V_D = 805 veh/h
	Freeway Volume, V_F: 4760	
	Ramp Volume, V_R: 656	
	Freeway Free-Flow Speed, S_{FF}: 60.0	
	Ramp Free-Flow Speed, S_{FR}: 45.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	4760	0.90	Level	4	0	0.980	1.00	5395
Ramp	656	0.90	Level	10	0	0.952	1.00	765
UpStream								
DownStream	805	0.90	Level	11	0	0.948	1.00	944

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = 5568.66 (Equation 13-6 or 13-7)

P_{FM} = 0.667 using Equation (Exhibit 13-6)

V_{12} = 3598 pc/h

V_3 or V_{av34} 1797 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * $V_{12}/2$ ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	6160	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	4363	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = 35.6 (pc/mi/ln)

LOS = E (Exhibit 13-2)

Speed Determination

M_S = 0.577 (Exibit 13-11)

S_R= 49.6 mph (Exhibit 13-11)

S_0= 55.3 mph (Exhibit 13-11)

S = 51.2 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * $V_{12}/2$ ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-26 EB
Agency or Company	Atkins	Junction	1150 - EB On from Dorchester
Date Performed	4/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2018 Build - River Center Site

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Freeway Number of Lanes, N: 3	☑ Yes ☐ On
☑ No ☐ Off	Ramp Number of Lanes, N: 1	☐ No ☑ Off
L_{up} = ft	Acceleration Lane Length, L_A: 560	L_{down} = 2100 ft
V_u = veh/h	Deceleration Lane Length L_D:	V_D = 1165 veh/h
	Freeway Volume, V_F: 3676	
	Ramp Volume, V_R: 508	
	Freeway Free-Flow Speed, S_{FF}: 60.0	
	Ramp Free-Flow Speed, S_{FR}: 45.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	3676	0.90	Level	3	0	0.985	1.00	4146
Ramp	508	0.90	Level	11	0	0.948	1.00	595
UpStream								
DownStream	1165	0.90	Level	7	0	0.966	1.00	1340

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = 7904.67 (Equation 13-6 or 13-7)

P_{FM} = 0.716 using Equation (Exhibit 13-6)

V_{12} = 2970 pc/h

V_3 or V_{av34} 1176 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * $V_{12}/2$ ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	4741	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	3565	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = 29.5 (pc/mi/ln)

LOS = D (Exhibit 13-2)

Speed Determination

M_S = 0.408 (Exibit 13-11)

S_R= 52.6 mph (Exhibit 13-11)

S_0= 57.6 mph (Exhibit 13-11)

S = 53.8 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * $V_{12}/2$ ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-26 EB
Agency or Company	Atkins	Junction	1160-EB Off to Cosgrove SB
Date Performed	3/20/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2018 Build - River Center Site

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp

☑ Yes ☑ On

☐ No ☐ Off

L_{up} = 2100 ft

V_u = 656 veh/h

Freeway Number of Lanes, N	3
Ramp Number of Lanes, N	1
Acceleration Lane Length, L_A	
Deceleration Lane Length L_D	200
Freeway Volume, V_F	5416
Ramp Volume, V_R	805
Freeway Free-Flow Speed, S_{FF}	60.0
Ramp Free-Flow Speed, S_{FR}	45.0

Downstream Adj Ramp

☐ Yes ☐ On

☑ No ☐ Off

L_{down} = ft

V_D = veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	5416	0.90	Level	4	0	0.980	1.00	6138
Ramp	805	0.90	Level	11	0	0.948	1.00	944
UpStream	656	0.90	Level	10	0	0.952	1.00	765
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * $V_{12}/2$ ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = 5447.55 (Equation 13-12 or 13-13)

P_{FD} = 0.563 using Equation (Exhibit 13-7)

V_{12} = 3869 pc/h

V_3 or V_{av34} 2269 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * $V_{12}/2$ ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	6138	Exhibit 13-8	6900	No
$V_{FO} = V_F - V_R$	5194	Exhibit 13-8	6900	No
V_R	944	Exhibit 13-10	2100	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	3869	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = 35.7 (pc/mi/ln)

LOS = E (Exhibit 13-2)

Speed Determination

D_s = 0.383 (Exhibit 13-12)

S_R= 53.1 mph (Exhibit 13-12)

S_0= 60.9 mph (Exhibit 13-12)

S = 55.7 mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-26 EB
Agency or Company	Atkins	Junction	1160-EB Off to Cosgrove SB
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2018 Build - River Center Site

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp

☑ Yes ☑ On

☐ No ☐ Off

L_{up} = 2100 ft

V_u = 508 veh/h

Freeway Number of Lanes, N	3
Ramp Number of Lanes, N	1
Acceleration Lane Length, L_A	
Deceleration Lane Length L_D	200
Freeway Volume, V_F	4184
Ramp Volume, V_R	1165
Freeway Free-Flow Speed, S_{FF}	60.0
Ramp Free-Flow Speed, S_{FR}	45.0

Downstream Adj Ramp

☐ Yes ☐ On

☑ No ☐ Off

L_{down} = ft

V_D = veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	4184	0.90	Level	3	0	0.985	1.00	4719
Ramp	1165	0.90	Level	7	0	0.966	1.00	1340
UpStream	508	0.90	Level	11	0	0.948	1.00	595
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = 7657.95 (Equation 13-12 or 13-13)

P_{FD} = 0.580 using Equation (Exhibit 13-7)

V_{12} = 3301 pc/h

V_3 or V_{av34} 1418 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	4719	Exhibit 13-8	6900	No
$V_{FO} = V_F - V_R$	3379	Exhibit 13-8	6900	No
V_R	1340	Exhibit 13-10	2100	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	3301	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = 30.8 (pc/mi/ln)

LOS = D (Exhibit 13-2)

Speed Determination

D_s = 0.419 (Exhibit 13-12)

S_R= 52.5 mph (Exhibit 13-12)

S_0= 64.2 mph (Exhibit 13-12)

S = 55.5 mph (Exhibit 13-13)

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-26 EB*
Agency or Company	*Atkins*	From/To	*1165-Cosg SB Off to Cosg SB On*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2018 Build - River Center Site*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*4611*	veh/h	Peak-Hour Factor, PHF	*0.90*	
AADT		veh/day	%Trucks and Buses, P_T	*4*	
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*	
Peak-Hr Direction Prop, D			General Terrain:	*Level*	
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*	

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.980*

Speed Inputs			Calc Speed Adj and FFS		
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f_{LW}		mph
Number of Lanes, N	*3*		f_{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	*60.0*	mph	FFS	*60.0*	mph
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures			Design (N)	
Operational (LOS)			Design (N)	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1742*	pc/h/ln	Design LOS	
S	*59.6*	mph	v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h/ln
D = v_p / S	*29.2*	pc/mi/ln	S	mph
LOS	*D*		D = v_p / S	pc/mi/ln
			Required Number of Lanes, N	

Glossary		Factor Location	
N - Number of lanes	S - Speed	E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
V - Hourly volume	D - Density	E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 11-18	TRD - Page 11-11
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 11-2, 11-3	
DDHV - Directional design hour volume			

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F-3804

BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-26 EB*
Agency or Company	*Atkins*	From/To	*1165-Cosg SB Off to Cosg SB On*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*PM Peak*	Analysis Year	*2018 Build - River Center Site*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*3019*	veh/h	Peak-Hour Factor, PHF	*0.90*	
AADT		veh/day	%Trucks and Buses, P_T	*3*	
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*	
Peak-Hr Direction Prop, D			General Terrain:	*Level*	
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*	

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.985*

Speed Inputs			Calc Speed Adj and FFS		
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f_{LW}		mph
Number of Lanes, N	*3*		f_{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	*60.0*	mph	FFS	*60.0*	mph
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures			Design (N)		
Operational (LOS)			Design (N)		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1135*	pc/h/ln	Design LOS		
S	*60.0*	mph	v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
D = v_p / S	*18.9*	pc/mi/ln	S		mph
LOS	*C*		D = v_p / S		pc/mi/ln
			Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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Navy Base ICTF

FREEWAY WEAVING WORKSHEET

General Information

Analyst	AJR
Agency/Company	Atkins
Date Performed	7/25/2014
Analysis Time Period	AM Peak

Site Information

Freeway/Dir of Travel	I-26 EB
Weaving Segment Location	1170 - Cosgrove SB to Cos. NB
Analysis Year	2018 Build - River Center Site

Project Description *Navy Base ICTF*

Inputs

Weaving configuration	One-Sided
Weaving number of lanes, N	4
Weaving segment length, L_S	600ft
Freeway free-flow speed, FFS	60 mph
Segment type	Freeway
Freeway minimum speed, S_{MIN}	15
Freeway maximum capacity, C_{IFL}	2300
Terrain type	Level

Conversions to pc/h Under Base Conditions

	V (veh/h)	PHF	Truck (%)	RV (%)	E_T	E_R	f_{HV}	fp	v (pc/h)
V_{FF}	4318	0.90	4	0	1.5	1.2	0.980	1.00	4894
V_{RF}	405	0.90	2	0	1.5	1.2	0.990	1.00	455
V_{FR}	293	0.90	8	0	1.5	1.2	0.962	1.00	339
V_{RR}	0	0.90	0	0	1.5	1.2	1.000	1.00	0
V_{NW}	4894							V =	5688
V_W	794								
VR	0.140								

Configuration Characteristics

Minimum maneuver lanes, N_{WL}	2 lc	Minimum weaving lane changes, LC_{MIN}	794 lc/h
Interchange density, ID	1.0 int/mi	Weaving lane changes, LC_W	982 lc/h
Minimum RF lane changes, LC_{RF}	1 lc/pc	Non-weaving lane changes, LC_{NW}	563 lc/h
Minimum FR lane changes, LC_{FR}	1 lc/pc	Total lane changes, LC_{ALL}	1545 lc/h
Minimum RR lane changes, LC_{RR}	lc/pc	Non-weaving vehicle index, I_{NW}	294

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment flow rate, v	5688 pc/h	Weaving intensity factor, W	0.477
Weaving segment capacity, c_w	8020 veh/h	Weaving segment speed, S	47.2 mph
Weaving segment v/c ratio	0.695	Average weaving speed, S_W	45.5 mph
Weaving segment density, D	30.1 pc/mi/ln	Average non-weaving speed, S_{NW}	47.5 mph
Level of Service, LOS	D	Maximum weaving length, L_{MAX}	3928 ft

Notes

a. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments".
b. For volumes that exceed the weaving segment capacity, the level of service is "F".

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Navy Base ICTF

FREEWAY WEAVING WORKSHEET

General Information

Analyst	AJR
Agency/Company	Atkins
Date Performed	7/25/2014
Analysis Time Period	PM Peak

Site Information

Freeway/Dir of Travel	I-26 EB
Weaving Segment Location	1170 - Cosgrove SB to Cos. NB
Analysis Year	2018 Build - River Center Site

Project Description *Navy Base ICTF*

Inputs

Weaving configuration	One-Sided
Weaving number of lanes, N	4
Weaving segment length, L_S	600ft
Freeway free-flow speed, FFS	60 mph
Segment type	Freeway
Freeway minimum speed, S_{MIN}	15
Freeway maximum capacity, C_{IFL}	2300
Terrain type	Level

Conversions to pc/h Under Base Conditions

	V (veh/h)	PHF	Truck (%)	RV (%)	E_T	E_R	f_{HV}	f_p	v (pc/h)
V_{FF}	2879	0.90	3	0	1.5	1.2	0.985	1.00	3247
V_{RF}	403	0.90	2	0	1.5	1.2	0.990	1.00	452
V_{FR}	140	0.90	14	0	1.5	1.2	0.935	1.00	166
V_{RR}	0	0.90	0	0	1.5	1.2	1.000	1.00	0
V_{NW}	3247							V =	3865
V_W	618								
VR	0.160								

Configuration Characteristics

Minimum maneuver lanes, N_{WL}	2 lc	Minimum weaving lane changes, LC_{MIN}	618 lc/h
Interchange density, ID	1.0 int/mi	Weaving lane changes, LC_W	806 lc/h
Minimum RF lane changes, LC_{RF}	1 lc/pc	Non-weaving lane changes, LC_{NW}	224 lc/h
Minimum FR lane changes, LC_{FR}	1 lc/pc	Total lane changes, LC_{ALL}	1030 lc/h
Minimum RR lane changes, LC_{RR}	lc/pc	Non-weaving vehicle index, I_{NW}	195

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment flow rate, v	3865 pc/h	Weaving intensity factor, W	0.346
Weaving segment capacity, c_w	8000 veh/h	Weaving segment speed, S	50.5 mph
Weaving segment v/c ratio	0.476	Average weaving speed, S_W	48.4 mph
Weaving segment density, D	19.1 pc/mi/ln	Average non-weaving speed, S_{NW}	50.9 mph
Level of Service, LOS	B	Maximum weaving length, L_{MAX}	4130 ft

Notes

a. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments".
b. For volumes that exceed the weaving segment capacity, the level of service is "F".

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-26 EB*
Agency or Company	*Atkins*	From/To	*1175-Cosg NB Off to Cosg NB On*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2018 Build - River Center Site*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*4723*	veh/h	Peak-Hour Factor, PHF	*0.90*	
AADT		veh/day	%Trucks and Buses, P_T	*4*	
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*	
Peak-Hr Direction Prop, D			General Terrain:	*Level*	
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*	

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.980*

Speed Inputs			Calc Speed Adj and FFS		
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f_{LW}		mph
Number of Lanes, N	*3*		f_{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	*60.0*	mph	FFS	*60.0*	mph
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures			Design (N)	
Operational (LOS)			Design (N)	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1784*	pc/h/ln	Design LOS	
			v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h/ln
S	*59.4*	mph	S	mph
D = v_p / S	*30.0*	pc/mi/ln	D = v_p / S	pc/mi/ln
LOS	*D*		Required Number of Lanes, N	

Glossary		Factor Location	
N - Number of lanes	S - Speed	E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
V - Hourly volume	D - Density	E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 11-18	TRD - Page 11-11
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 11-2, 11-3	
DDHV - Directional design hour volume			

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-26 EB*
Agency or Company	*Atkins*	From/To	*1175-Cosg NB Off to Cosg NB On*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*PM Peak*	Analysis Year	*2018 Build - River Center Site*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*3282*	veh/h	Peak-Hour Factor, PHF	*0.90*	
AADT		veh/day	%Trucks and Buses, P_T	*3*	
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*	
Peak-Hr Direction Prop, D			General Terrain:	*Level*	
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*	

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.985*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*3*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*60.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*60.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1234*	pc/h/ln
S	*60.0*	mph
D = v_p / S	*20.6*	pc/mi/ln
LOS	*C*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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F-3809

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-26 EB
Agency or Company	Atkins	Junction	1180 - EB On from Cosgrove NB
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2018 Build - River Center Site

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Freeway Number of Lanes, N	3	Downstream Adj Ramp	
☐ Yes	☐ On	Ramp Number of Lanes, N	1	☐ Yes	☐ On
☑ No	☐ Off	Acceleration Lane Length, L_A	440	☑ No	☐ Off
L_{up} =	ft	Deceleration Lane Length L_D		L_{down} =	ft
V_u =	veh/h	Freeway Volume, V_F	4723	V_D =	veh/h
		Ramp Volume, V_R	854		
		Freeway Free-Flow Speed, S_{FF}	60.0		
		Ramp Free-Flow Speed, S_{FR}	45.0		

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	4723	0.90	Level	4	0	0.980	1.00	5353
Ramp	854	0.90	Level	12	0	0.943	1.00	1006
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 0.590 using Equation (Exhibit 13-6)

V_{12} = 3157 pc/h

V_3 or V_{av34} 2196 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * $V_{12}/2$ ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	6359	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	4163	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = 34.7 (pc/mi/ln)

LOS = D (Exhibit 13-2)

Speed Determination

M_S = 0.532 (Exibit 13-11)

S_R= 50.4 mph (Exhibit 13-11)

S_0= 53.9 mph (Exhibit 13-11)

S = 51.6 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * $V_{12}/2$ ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-26 EB
Agency or Company	Atkins	Junction	1180 - EB On from Cosgrove NB
Date Performed	4/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2018 Build - River Center Site

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Freeway Number of Lanes, N: 3	☐ Yes ☐ On
☑ No ☐ Off	Ramp Number of Lanes, N: 1	☑ No ☐ Off
L_{up} = ft	Acceleration Lane Length, L_A: 440	L_{down} = ft
V_u = veh/h	Deceleration Lane Length L_D:	V_D = veh/h
	Freeway Volume, V_F: 3282	
	Ramp Volume, V_R: 461	
	Freeway Free-Flow Speed, S_{FF}: 60.0	
	Ramp Free-Flow Speed, S_{FR}: 45.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	3282	0.90	Level	3	0	0.985	1.00	3701
Ramp	461	0.90	Level	19	0	0.913	1.00	561
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 0.590 using Equation (Exhibit 13-6)

V_{12} = 2183 pc/h

V_3 or V_{av34} 1518 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * $V_{12}/2$ ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	4262	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	2744	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = 23.9 (pc/mi/ln)

LOS = C (Exhibit 13-2)

Speed Determination

M_S = 0.342 (Exibit 13-11)

S_R= 53.8 mph (Exhibit 13-11)

S_0= 56.3 mph (Exhibit 13-11)

S = 54.7 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * $V_{12}/2$ ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-26 EB*
Agency or Company	*Atkins*	From/To	*1190 - Cosgrove to US-52*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2018 Build - River Center Site*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*5577*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*3*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.985*

Speed Inputs			Calc Speed Adj and FFS		
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f_{LW}		mph
Number of Lanes, N	*3*		f_{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	*60.0*	mph	FFS	*60.0*	mph
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures			Design (N)	
Operational (LOS)			Design (N)	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*2097*	pc/h/ln	Design LOS	
S	*55.5*	mph	v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h/ln
D = v_p / S	*37.8*	pc/mi/ln	S	mph
LOS	*E*		D = v_p / S	pc/mi/ln
			Required Number of Lanes, N	

Glossary		Factor Location	
N - Number of lanes	S - Speed	E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
V - Hourly volume	D - Density	E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 11-18	TRD - Page 11-11
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 11-2, 11-3	
DDHV - Directional design hour volume			

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-26 EB*
Agency or Company	*Atkins*	From/To	*1190 - Cosgrove to US-52*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*PM Peak*	Analysis Year	*2018 Build - River Center Site*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs				
Volume, V	*3743*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*3*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.985*

Speed Inputs			Calc Speed Adj and FFS		
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f_{LW}		mph
Number of Lanes, N	*3*		f_{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	*60.0*	mph	FFS	*60.0*	mph
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures			Design (N)	
Operational (LOS)			Design (N)	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1407*	pc/h/ln	Design LOS	
S	*60.0*	mph	v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h/ln
D = v_p / S	*23.5*	pc/mi/ln	S	mph
LOS	*C*		D = v_p / S	pc/mi/ln
			Required Number of Lanes, N	

Glossary		Factor Location	
N - Number of lanes	S - Speed	E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
V - Hourly volume	D - Density	E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 11-18	TRD - Page 11-11
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 11-2, 11-3	
DDHV - Directional design hour volume			

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F-3813

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-26 EB
Agency or Company	Atkins	Junction	1200-EB Off to US-52 & PAR
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2018 Build - River Center Site

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Freeway Number of Lanes, N	3	Downstream Adj Ramp	
☐ Yes	☐ On	Ramp Number of Lanes, N	1	☐ Yes	☐ On
☑ No	☐ Off	Acceleration Lane Length, L_A		☑ No	☐ Off
L_{up} =	ft	Deceleration Lane Length L_D	340	L_{down} =	ft
V_u =	veh/h	Freeway Volume, V_F	5577	V_D =	veh/h
		Ramp Volume, V_R	372		
		Freeway Free-Flow Speed, S_{FF}	60.0		
		Ramp Free-Flow Speed, S_{FR}	45.0		

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	5577	0.90	Level	3	0	0.985	1.00	6290
Ramp	372	0.90	Level	20	0	0.909	1.00	455
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 0.582 using Equation (Exhibit 13-7)

V_{12} = 3850 pc/h

V_3 or V_{av34} 2440 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	6290	Exhibit 13-8	6900	No
$V_{FO} = V_F - V_R$	5835	Exhibit 13-8	6900	No
V_R	455	Exhibit 13-10	2100	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	3850	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = 34.3 (pc/mi/ln)

LOS = D (Exhibit 13-2)

Speed Determination

D_s = 0.339 (Exhibit 13-12)

S_R= 53.9 mph (Exhibit 13-12)

S_0= 60.2 mph (Exhibit 13-12)

S = 56.2 mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-26 EB
Agency or Company	Atkins	Junction	1200-EB Off to US-52
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2018 Build - River Center Site

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp
☐ Yes ☐ On
☑ No ☐ Off
L_{up} = ft
V_u = veh/h

Freeway Number of Lanes, N	3
Ramp Number of Lanes, N	1
Acceleration Lane Length, L_A	
Deceleration Lane Length L_D	340
Freeway Volume, V_F	3743
Ramp Volume, V_R	348
Freeway Free-Flow Speed, S_{FF}	60.0
Ramp Free-Flow Speed, S_{FR}	45.0

Downstream Adj Ramp
☐ Yes ☐ On
☑ No ☐ Off
L_{down} = ft
V_D = veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	3743	0.90	Level	3	0	0.985	1.00	4221
Ramp	348	0.90	Level	18	0	0.917	1.00	421
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)
P_{FM} = using Equation (Exhibit 13-6)
V_{12} = pc/h
V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)
Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No
Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No
If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = (pc/mi/ln)
LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)
S_R= mph (Exhibit 13-11)
S_0= mph (Exhibit 13-11)
S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)
P_{FD} = 0.635 using Equation (Exhibit 13-7)
V_{12} = 2834 pc/h
V_3 or V_{av34} 1387 pc/h (Equation 13-14 or 13-17)
Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No
Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No
If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	4221	Exhibit 13-8	6900	No
$V_{FO} = V_F - V_R$	3800	Exhibit 13-8	6900	No
V_R	421	Exhibit 13-10	2100	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	2834	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = 25.6 (pc/mi/ln)
LOS = C (Exhibit 13-2)

Speed Determination

D_s = 0.336 (Exhibit 13-12)
S_R= 54.0 mph (Exhibit 13-12)
S_0= 64.3 mph (Exhibit 13-12)
S = 57.0 mph (Exhibit 13-13)

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-26 EB*
Agency or Company	*Atkins*	From/To	*1205 - PAR Off to PAR On*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2018 Build - River Center Site*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*5205*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*4*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.980*

Speed Inputs			Calc Speed Adj and FFS		
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f_{LW}		mph
Number of Lanes, N	*3*		f_{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	*60.0*	mph	FFS	*60.0*	mph
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures			Design (N)	
Operational (LOS)			Design (N)	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1966*	pc/h/ln	Design LOS	
S	*57.6*	mph	v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h/ln
D = v_p / S	*34.2*	pc/mi/ln	S	mph
LOS	*D*		D = v_p / S	pc/mi/ln
			Required Number of Lanes, N	

Glossary		Factor Location	
N - Number of lanes	S - Speed	E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
V - Hourly volume	D - Density	E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 11-18	TRD - Page 11-11
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 11-2, 11-3	
DDHV - Directional design hour volume			

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-26 EB*
Agency or Company	*Atkins*	From/To	*1205 - PAR Off to PAR On*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*PM Peak*	Analysis Year	*2018 Build - River Center Site*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*3395*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*3*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.985*

Speed Inputs			Calc Speed Adj and FFS		
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f_{LW}		mph
Number of Lanes, N	*3*		f_{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	*60.0*	mph	FFS	*60.0*	mph
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures			Design (N)	
Operational (LOS)			Design (N)	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1276*	pc/h/ln	Design LOS	
S	*60.0*	mph	v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h/ln
D = v_p / S	*21.3*	pc/mi/ln	S	mph
LOS	*C*		D = v_p / S	pc/mi/ln
			Required Number of Lanes, N	

Glossary		Factor Location	
N - Number of lanes	S - Speed	E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
V - Hourly volume	D - Density	E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 11-18	TRD - Page 11-11
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 11-2, 11-3	
DDHV - Directional design hour volume			

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F-3817

RAMP ADD OR DROP LANE ANALYSIS (MAINLINE <55 MPH)

ATKINS

General Information

Date Performed:	3/20/2014	Freeway/Direction	EB US-52 & PAR Off Ramp
Analysis Year	2018 Build-River Center Site	Junction	US-52 & PAR EB Ramp Split
Analysis Time Period:	AM Peak	Segment ID	1208
Project Description:	Navy Base ICTF		

Inputs

	Mainline Upstream Ramp	Mainline Downstream Ramp	Ramp
Number of Lanes, N	1	1	1
Free-Flow Speed, FFS (mph)	45	55	45
Volume, V (veh/h)	372	264	108
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	20%	28%	3%
%RVs, P_R	0%	0%	0%

Performance Measures

	Upstream of Off-Ramp	Downstream of Off-Ramp	Off-Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.91	0.88	0.99
Demand Flow Rate, v_p (pc/h/ln)	455	334	122
Capacity Flow Rate, c (pc/h/ln)	2,100	2,200	2,100
v/c ratio	0.22	0.15	0.06
Density, D_{MD} (pc/mi/ln)	8.0	5.8	2.1
LOS	A	A	A

Formulas and Reference Material

$$f_{HV} = \frac{1}{1+P_T(E_T-1)+P_R(E_R-1)}$$ HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P}$$ HCM 2010, Equation 11-2

$$D_{MD} = \frac{0.0175*v_f}{N}$$ HCM 2010, Equation 13-26

Ramp Roadways Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

Diverge LOS Thresholds

LOS	Density (pc/mi/ln)
A	≤10
B	>10-20
C	>20-28
D	>28-35
E	>35
F	v/c > 1

Source: HCM 2010, Exhibit 13-2

RAMP ADD OR DROP LANE ANALYSIS (MAINLINE <55 MPH)

ATKINS

General Information

Date Performed:	3/20/2014	Freeway/Direction	EB US-52 & PAR Off Ramp
Analysis Year	2018 Build-River Center Site	Junction	US-52 & PAR EB Ramp Split
Analysis Time Period:	PM Peak	Segment ID	1208
Project Description:	Navy Base ICTF		

Inputs

	Mainline Upstream Ramp	Mainline Downstream Ramp	Ramp
Number of Lanes, N	1	1	1
Free-Flow Speed, FFS (mph)	45	55	45
Volume, V (veh/h)	348	297	51
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	18%	21%	2%
%RVs, P_R	0%	0%	0%

Performance Measures

	Upstream of Off-Ramp	Downstream of Off-Ramp	Off-Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.92	0.90	0.99
Demand Flow Rate, v_p (pc/h/ln)	421	365	57
Capacity Flow Rate, c (pc/h/ln)	2,100	2,200	2,100
v/c ratio	0.20	0.17	0.03
Density, D_{MD} (pc/mi/ln)	7.4	6.4	1.0
LOS	A	A	A

Formulas and Reference Material

$$f_{HV} = \frac{1}{1+P_T(E_T-1)+P_R(E_R-1)}$$ HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P}$$ HCM 2010, Equation 11-2

$$D_{MD} = \frac{0.0175*v_f}{N}$$ HCM 2010, Equation 13-26

Ramp Roadways Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

Diverge LOS Thresholds

LOS	Density (pc/mi/ln)
A	≤10
B	>10-20
C	>20-28
D	>28-35
E	>35
F	v/c > 1

Source: HCM 2010, Exhibit 13-2

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-26 EB
Agency or Company	Atkins	Junction	1210 - EB On from PAR
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2018 Build - River Center Site

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Freeway Number of Lanes, N: 3	☐ Yes ☐ On
☑ No ☐ Off	Ramp Number of Lanes, N: 1	☑ No ☐ Off
L_{up} = ft	Acceleration Lane Length, L_A: 1000	L_{down} = ft
V_u = veh/h	Deceleration Lane Length L_D	V_D = veh/h
	Freeway Volume, V_F: 5205	
	Ramp Volume, V_R: 95	
	Freeway Free-Flow Speed, S_{FF}: 60.0	
	Ramp Free-Flow Speed, S_{FR}: 55.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	5205	0.90	Level	4	0	0.980	1.00	5899
Ramp	95	0.90	Level	3	0	0.985	1.00	107
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 0.605 using Equation (Exhibit 13-6)

V_{12} = 3572 pc/h

V_3 or V_{av34} 2327 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * $V_{12}/2$ ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	6006	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	3679	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = 27.9 (pc/mi/ln)

LOS = C (Exhibit 13-2)

Speed Determination

M_S = 0.365 (Exibit 13-11)

S_R= 53.4 mph (Exhibit 13-11)

S_0= 53.3 mph (Exhibit 13-11)

S = 53.4 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * $V_{12}/2$ ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-26 EB
Agency or Company	Atkins	Junction	1210 - EB On from PAR
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2018 Build - River Center Site

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Freeway Number of Lanes, N: 3	☐ Yes ☐ On
☑ No ☐ Off	Ramp Number of Lanes, N: 1	☑ No ☐ Off
L_{up} = ft	Acceleration Lane Length, L_A: 1000	L_{down} = ft
V_u = veh/h	Deceleration Lane Length L_D	V_D = veh/h
	Freeway Volume, V_F: 3395	
	Ramp Volume, V_R: 203	
	Freeway Free-Flow Speed, S_{FF}: 60.0	
	Ramp Free-Flow Speed, S_{FR}: 55.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	3395	0.90	Level	3	0	0.985	1.00	3829
Ramp	203	0.90	Level	2	0	0.990	1.00	228
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 0.605 using Equation (Exhibit 13-6)

V_{12} = 2318 pc/h

V_3 or V_{av34} 1511 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * $V_{12}/2$ ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	4057	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	2546	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = 19.0 (pc/mi/ln)

LOS = B (Exhibit 13-2)

Speed Determination

M_S = 0.261 (Exibit 13-11)

S_R= 55.3 mph (Exhibit 13-11)

S_0= 56.4 mph (Exhibit 13-11)

S = 55.7 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * $V_{12}/2$ ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-26 EB*
Agency or Company	*Atkins*	From/To	*1220 - PAR to Heriot*
Date Performed	*4/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2018 Build - River Center Site*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*5300*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*4*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.980*

Speed Inputs			Calc Speed Adj and FFS		
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f_{LW}		mph
Number of Lanes, N	*3*		f_{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	*60.0*	mph	FFS	*60.0*	mph
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures			Design (N)	
Operational (LOS)			Design (N)	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*2002*	pc/h/ln	Design LOS	
S	*57.1*	mph	v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h/ln
D = v_p / S	*35.1*	pc/mi/ln	S	mph
LOS	*E*		D = v_p / S	pc/mi/ln
			Required Number of Lanes, N	

Glossary		Factor Location	
N - Number of lanes	S - Speed	E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
V - Hourly volume	D - Density	E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 11-18	TRD - Page 11-11
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 11-2, 11-3	
DDHV - Directional design hour volume			

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-26 EB*
Agency or Company	*Atkins*	From/To	*1220 - PAR to Heriot*
Date Performed	*4/25/2014*	Jurisdiction	
Analysis Time Period	*PM Peak*	Analysis Year	*2018 Build - River Center Site*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*3598*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*3*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.985*

Speed Inputs			Calc Speed Adj and FFS		
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f_{LW}		mph
Number of Lanes, N	*3*		f_{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	*60.0*	mph	FFS	*60.0*	mph
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures			Design (N)	
Operational (LOS)			Design (N)	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1353*	pc/h/ln	Design LOS	
S	*60.0*	mph	v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h/ln
D = v_p / S	*22.5*	pc/mi/ln	S	mph
LOS	*C*		D = v_p / S	pc/mi/ln
			Required Number of Lanes, N	

Glossary		Factor Location	
N - Number of lanes	S - Speed	E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
V - Hourly volume	D - Density	E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 11-18	TRD - Page 11-11
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 11-2, 11-3	
DDHV - Directional design hour volume			

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-26 EB
Agency or Company	Atkins	Junction	1230-EB Off to Heriot St
Date Performed	3/20/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2018 Build - River Center Site

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp

☐ Yes ☐ On

☑ No ☐ Off

L_{up} = ft

V_u = veh/h

Freeway Number of Lanes, N	3
Ramp Number of Lanes, N	1
Acceleration Lane Length, L_A	
Deceleration Lane Length L_D	200
Freeway Volume, V_F	5300
Ramp Volume, V_R	675
Freeway Free-Flow Speed, S_{FF}	55.0
Ramp Free-Flow Speed, S_{FR}	45.0

Downstream Adj Ramp

☑ Yes ☐ On

☐ No ☑ Off

L_{down} = 1400 ft

V_D = 779 veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	5300	0.90	Level	4	0	0.980	1.00	6007
Ramp	675	0.90	Level	4	0	0.980	1.00	765
UpStream								
DownStream	779	0.90	Level	8	0	0.962	1.00	900

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = 1333.67 (Equation 13-12 or 13-13)

P_{FD} = 0.575 using Equation (Exhibit 13-7)

V_{12} = 3777 pc/h

V_3 or V_{av34} 2230 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	6007	Exhibit 13-8	6750	No
$V_{FO} = V_F - V_R$	5242	Exhibit 13-8	6750	No
V_R	765	Exhibit 13-10	2100	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	3777	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = 34.9 (pc/mi/ln)

LOS = D (Exhibit 13-2)

Speed Determination

D_s = 0.367 (Exhibit 13-12)

S_R= 50.2 mph (Exhibit 13-12)

S_0= 55.5 mph (Exhibit 13-12)

S = 52.1 mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-26 EB
Agency or Company	Atkins	Junction	1230-EB Off to Heriot St
Date Performed	3/20/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2018 Build - River Center Site

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Freeway Number of Lanes, N	3	Downstream Adj Ramp	
☐ Yes	☐ On	Ramp Number of Lanes, N	1	☑ Yes	☐ On
☑ No	☐ Off	Acceleration Lane Length, L_A		☐ No	☑ Off
L_{up} =	ft	Deceleration Lane Length L_D	200	L_{down} =	1400 ft
V_u =	veh/h	Freeway Volume, V_F	3598	V_D =	356 veh/h
		Ramp Volume, V_R	478		
		Freeway Free-Flow Speed, S_{FF}	55.0		
		Ramp Free-Flow Speed, S_{FR}	45.0		

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	3598	0.90	Level	3	0	0.985	1.00	4058
Ramp	478	0.90	Level	4	0	0.980	1.00	542
UpStream								
DownStream	356	0.90	Level	14	0	0.935	1.00	423

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = 516.04 (Equation 13-12 or 13-13)

P_{FD} = 0.634 using Equation (Exhibit 13-7)

V_{12} = 2770 pc/h

V_3 or V_{av34} 1288 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	4058	Exhibit 13-8	6750	No
$V_{FO} = V_F - V_R$	3516	Exhibit 13-8	6750	No
V_R	542	Exhibit 13-10	2100	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	2770	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = 26.3 (pc/mi/ln)

LOS = C (Exhibit 13-2)

Speed Determination

D_s = 0.347 (Exhibit 13-12)

S_R= 50.5 mph (Exhibit 13-12)

S_0= 59.2 mph (Exhibit 13-12)

S = 53.0 mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-26 EB
Agency or Company	Atkins	Junction	1240-EB Off to Mt. Pleasant St
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2018 Build - River Center Site

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Freeway Number of Lanes, N	3	Downstream Adj Ramp	
☐ Yes	☐ On	Ramp Number of Lanes, N	1	☐ Yes	☐ On
☑ No	☐ Off	Acceleration Lane Length, L_A		☑ No	☐ Off
L_{up} =	ft	Deceleration Lane Length L_D	175	L_{down} =	ft
V_u =	veh/h	Freeway Volume, V_F	4625	V_D =	veh/h
		Ramp Volume, V_R	779		
		Freeway Free-Flow Speed, S_{FF}	55.0		
		Ramp Free-Flow Speed, S_{FR}	45.0		

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	4625	0.90	Level	4	0	0.980	1.00	5242
Ramp	779	0.90	Level	8	0	0.962	1.00	900
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 0.588 using Equation (Exhibit 13-7)

V_{12} = 3451 pc/h

V_3 or V_{av34} 1791 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	5242	Exhibit 13-8	6750	No
$V_{FO} = V_F - V_R$	4342	Exhibit 13-8	6750	No
V_R	900	Exhibit 13-10	2100	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	3451	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = 32.4 (pc/mi/ln)

LOS = D (Exhibit 13-2)

Speed Determination

D_s = 0.379 (Exhibit 13-12)

S_R= 50.1 mph (Exhibit 13-12)

S_0= 57.3 mph (Exhibit 13-12)

S = 52.3 mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-26 EB
Agency or Company	Atkins	Junction	1240-EB Off to Mt. Pleasant St
Date Performed	3/20/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2018 Build - River Center Site

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Freeway Number of Lanes, N	3	Downstream Adj Ramp	
☐ Yes	☐ On	Ramp Number of Lanes, N	1	☐ Yes	☐ On
☑ No	☐ Off	Acceleration Lane Length, L_A		☑ No	☐ Off
L_{up} =	ft	Deceleration Lane Length L_D	175	L_{down} =	ft
V_u =	veh/h	Freeway Volume, V_F	3120	V_D =	veh/h
		Ramp Volume, V_R	356		
		Freeway Free-Flow Speed, S_{FF}	55.0		
		Ramp Free-Flow Speed, S_{FR}	45.0		

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	3120	0.90	Level	3	0	0.985	1.00	3519
Ramp	356	0.90	Level	14	0	0.935	1.00	423
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 0.653 using Equation (Exhibit 13-7)

V_{12} = 2443 pc/h

V_3 or V_{av34} 1076 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	3519	Exhibit 13-8	6750	No
$V_{FO} = V_F - V_R$	3096	Exhibit 13-8	6750	No
V_R	423	Exhibit 13-10	2100	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	2443	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = 23.7 (pc/mi/ln)

LOS = C (Exhibit 13-2)

Speed Determination

D_s = 0.336 (Exhibit 13-12)

S_R= 50.6 mph (Exhibit 13-12)

S_0= 60.0 mph (Exhibit 13-12)

S = 53.2 mph (Exhibit 13-13)

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FREEWAY RAMP ADD OR DROP LANE ANALYSIS

ATKINS

General Information

Date Performed:	7/25/2014	Freeway/Direction	I-26 EB
Analysis Year	2018 Build-River Center Site	Junction	EB Off to US-17 NB
Analysis Time Period:	AM Peak	Segment ID	1250
Project Description:	Navy Base ICTF		

Inputs

	Freeway Upstream of Ramp	Freeway Downstream of Ramp	Ramp
Number of Lanes, N	3	2	1
Free-Flow Speed, FFS (mph)	55	55	55
Volume, V (veh/h)	3,846	2,540	1,306
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	3%	3%	2%
%RVs, P_R	0%	0%	0%

Performance Measures

	Freeway Upstream Ramp	Freeway Downstream Ramp	Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.99	0.99	0.99
Demand Flow Rate, v_p (pc/h/ln)	1,446	1,432	1,466
Capacity Flow Rate, c (pc/h/ln)	2,250	2,250	2,200
v/c ratio	0.64	0.64	0.67
Density, D_{MD} (pc/mi/ln)	25.3	25.1	25.7
LOS	C	C	C

Formulas and Reference Material

$$f_{HV} = \frac{1}{1 + P_T(E_T-1)+P_R(E_R-1)}$$ HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P}$$ HCM 2010, Equation 11-2

$$D_{MD} = \frac{0.0175*v_f}{N}$$ HCM 2010, Equation 13-26

Basic Freeway Segments Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
75	2,400
70	2,400
65	2,350
60	2,300
55	2,250

Source: HCM 2010, Exhibit 11-17

Ramp Roadways Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

Diverge LOS Thresholds

LOS	Density (pc/mi/ln)
A	≤10
B	>10-20
C	>20-28
D	>28-35
E	>35
F	v/c > 1

Source: HCM 2010, Exhibit 13-2

FREEWAY RAMP ADD OR DROP LANE ANALYSIS

ATKINS

General Information

Date Performed:	7/25/2014	Freeway/Direction	I-26 EB
Analysis Year	2018 Build-River Center Site	Junction	EB Off to US-17 NB
Analysis Time Period:	PM Peak	Segment ID	1250
Project Description:	Navy Base ICTF		

Inputs

	Freeway Upstream of Ramp	Freeway Downstream of Ramp	Ramp
Number of Lanes, N	3	2	1
Free-Flow Speed, FFS (mph)	55	55	55
Volume, V (veh/h)	2,764	2,088	676
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	3%	3%	3%
%RVs, P_R	0%	0%	0%

Performance Measures

	Freeway Upstream Ramp	Freeway Downstream Ramp	Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.99	0.99	0.99
Demand Flow Rate, v_p (pc/h/ln)	1,039	1,177	762
Capacity Flow Rate, c (pc/h/ln)	2,250	2,250	2,200
v/c ratio	0.46	0.52	0.35
Density, D_{MD} (pc/mi/ln)	18.2	20.6	13.3
LOS	B	C	B

Formulas and Reference Material

$$f_{HV} = \frac{1}{1 + P_T(E_T-1)+P_R(E_R-1)}$$ HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P}$$ HCM 2010, Equation 11-2

$$D_{MD} = \frac{0.0175*v_f}{N}$$ HCM 2010, Equation 13-26

Basic Freeway Segments Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
75	2,400
70	2,400
65	2,350
60	2,300
55	2,250

Source: HCM 2010, Exhibit 11-17

Ramp Roadways Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

Diverge LOS Thresholds

LOS	Density (pc/mi/ln)
A	≤10
B	>10-20
C	>20-28
D	>28-35
E	>35
F	v/c > 1

Source: HCM 2010, Exhibit 13-2

BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-26 EB*
Agency or Company	*Atkins*	From/To	*1260 - US17 NB to Cypress St*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2018 Build - River Center Site*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*2540*	veh/h	Peak-Hour Factor, PHF	*0.90*	
AADT		veh/day	%Trucks and Buses, P_T	*3*	
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*	
Peak-Hr Direction Prop, D			General Terrain:	*Level*	
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*	

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.985*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*55.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*55.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1432*	pc/h/ln
S	*55.0*	mph
D = v_p / S	*26.0*	pc/mi/ln
LOS	*D*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-26 EB*
Agency or Company	*Atkins*	From/To	*1260 - US17 NB to Cypress St*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*PM Peak*	Analysis Year	*2018 Build - River Center Site*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*2088*	veh/h	Peak-Hour Factor, PHF	*0.90*	
AADT		veh/day	%Trucks and Buses, P_T	*3*	
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*	
Peak-Hr Direction Prop, D			General Terrain:	*Level*	
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*	

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.985*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*55.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*55.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1177*	pc/h/ln
S	*55.0*	mph
D = v_p / S	*21.4*	pc/mi/ln
LOS	*C*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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FREEWAY RAMP ADD OR DROP LANE ANALYSIS

ATKINS

General Information

Date Performed:	7/25/2014	Freeway/Direction	I-26 EB
Analysis Year	2018 Build-River Center Site	Junction	EB On from Cypress St
Analysis Time Period:	AM Peak	Segment ID	1270
Project Description:	Navy Base ICTF		

Inputs

	Freeway Upstream of Ramp	Freeway Downstream of Ramp	Ramp
Number of Lanes, N	2	3	1
Free-Flow Speed, FFS (mph)	55	55	45
Volume, V (veh/h)	2,540	2,646	106
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	3%	3%	20%
%RVs, P_R	0%	0%	0%

Performance Measures

	Freeway Upstream Ramp	Freeway Downstream Ramp	Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.99	0.99	0.91
Demand Flow Rate, v_p (pc/h/ln)	1,432	995	130
Capacity Flow Rate, c (pc/h/ln)	2,250	2,250	2,100
v/c ratio	0.64	0.44	0.06
Density, D_{MD} (pc/mi/ln)	25.1	17.4	2.3
LOS	C	B	A

Formulas and Reference Material

$$f_{HV} = \frac{1}{1 + P_T(E_T-1)+P_R(E_R-1)}$$ HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P}$$ HCM 2010, Equation 11-2

$$D_{MD} = \frac{0.0175*v_f}{N}$$ HCM 2010, Equation 13-26

Basic Freeway Segments Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
75	2,400
70	2,400
65	2,350
60	2,300
55	2,250

Source: HCM 2010, Exhibit 11-17

Ramp Roadways Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

Diverge LOS Thresholds

LOS	Density (pc/mi/ln)
A	≤10
B	>10-20
C	>20-28
D	>28-35
E	>35
F	v/c > 1

Source: HCM 2010, Exhibit 13-2

FREEWAY RAMP ADD OR DROP LANE ANALYSIS

ATKINS

General Information

Date Performed:	7/25/2014	Freeway/Direction	I-26 EB
Analysis Year	2018 Build-River Center Site	Junction	EB On from Cypress St
Analysis Time Period:	PM Peak	Segment ID	1270
Project Description:	Navy Base ICTF		

Inputs

	Freeway Upstream of Ramp	Freeway Downstream of Ramp	Ramp
Number of Lanes, N	2	3	1
Free-Flow Speed, FFS (mph)	55	55	45
Volume, V (veh/h)	2,088	2,267	179
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	3%	3%	10%
%RVs, P_R	0%	0%	0%

Performance Measures

	Freeway Upstream Ramp	Freeway Downstream Ramp	Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.99	0.99	0.95
Demand Flow Rate, v_p (pc/h/ln)	1,177	852	209
Capacity Flow Rate, c (pc/h/ln)	2,250	2,250	2,100
v/c ratio	0.52	0.38	0.10
Density, D_{MD} (pc/mi/ln)	20.6	14.9	3.7
LOS	C	B	A

Formulas and Reference Material

$$f_{HV} = \frac{1}{1+P_T(E_T-1)+P_R(E_R-1)}$$ HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P}$$ HCM 2010, Equation 11-2

$$D_{MD} = \frac{0.0175*v_f}{N}$$ HCM 2010, Equation 13-26

Basic Freeway Segments Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
75	2,400
70	2,400
65	2,350
60	2,300
55	2,250

Source: HCM 2010, Exhibit 11-17

Ramp Roadways Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

Diverge LOS Thresholds

LOS	Density (pc/mi/ln)
A	≤10
B	>10-20
C	>20-28
D	>28-35
E	>35
F	v/c > 1

Source: HCM 2010, Exhibit 13-2

BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-26 EB*
Agency or Company	*Atkins*	From/To	*1280 - East Of Cypress*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2018 Build - River Center Site*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*2646*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*3*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.985*

Speed Inputs			Calc Speed Adj and FFS		
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f_{LW}		mph
Number of Lanes, N	*3*		f_{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	*55.0*	mph	FFS	*55.0*	mph
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures			Design (N)	
Operational (LOS)			Design (N)	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*995*	pc/h/ln	Design LOS	
			v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h/ln
S	*55.0*	mph	S	mph
D = v_p / S	*18.1*	pc/mi/ln	D = v_p / S	pc/mi/ln
LOS	*C*		Required Number of Lanes, N	

Glossary		Factor Location	
N - Number of lanes	S - Speed	E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
V - Hourly volume	D - Density	E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 11-18	TRD - Page 11-11
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 11-2, 11-3	
DDHV - Directional design hour volume			

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-26 EB*
Agency or Company	*Atkins*	From/To	*1280 - East Of Cypress*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*PM Peak*	Analysis Year	*2018 Build - River Center Site*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*2267*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*3*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.985*

Speed Inputs			Calc Speed Adj and FFS		
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f_{LW}		mph
Number of Lanes, N	*3*		f_{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	*55.0*	mph	FFS	*55.0*	mph
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures			Design (N)	
Operational (LOS)			Design (N)	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*852*	pc/h/ln	Design LOS	
			v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h/ln
S	*55.0*	mph	S	mph
D = v_p / S	*15.5*	pc/mi/ln	D = v_p / S	pc/mi/ln
LOS	*B*		Required Number of Lanes, N	

Glossary		Factor Location	
N - Number of lanes	S - Speed	E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
V - Hourly volume	D - Density	E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 11-18	TRD - Page 11-11
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 11-2, 11-3	
DDHV - Directional design hour volume			

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FREEWAY RAMP ADD OR DROP LANE ANALYSIS

ATKINS

General Information

Date Performed:	7/25/2014	Freeway/Direction	I-26 WB
Analysis Year	2018 Build-River Center Site	Junction	WB Off to US-17 NB
Analysis Time Period:	AM Peak	Segment ID	2010
Project Description:	Navy Base ICTF		

Inputs

	Freeway Upstream of Ramp	Freeway Downstream of Ramp	Ramp
Number of Lanes, N	4	3	2
Free-Flow Speed, FFS (mph)	55	55	55
Volume, V (veh/h)	3,298	1,516	1,782
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	3%	4%	2%
%RVs, P_R	0%	0%	0%

Performance Measures

	Freeway Upstream Ramp	Freeway Downstream Ramp	Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.99	0.98	0.99
Demand Flow Rate, v_p (pc/h/ln)	930	573	1,000
Capacity Flow Rate, c (pc/h/ln)	2,250	2,250	2,200
v/c ratio	0.41	0.25	0.45
Density, D_{MD} (pc/mi/ln)	16.3	10.0	17.5
LOS	B	A	B

Formulas and Reference Material

$$f_{HV} = \frac{1}{1 + P_T(E_T-1)+P_R(E_R-1)}$$ HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P}$$ HCM 2010, Equation 11-2

$$D_{MD} = \frac{0.0175*v_f}{N}$$ HCM 2010, Equation 13-26

Basic Freeway Segments Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
75	2,400
70	2,400
65	2,350
60	2,300
55	2,250

Source: HCM 2010, Exhibit 11-17

Ramp Roadways Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

Diverge LOS Thresholds

LOS	Density (pc/mi/ln)
A	≤10
B	>10-20
C	>20-28
D	>28-35
E	>35
F	v/c > 1

Source: HCM 2010, Exhibit 13-2

FREEWAY RAMP ADD OR DROP LANE ANALYSIS

ATKINS

General Information

Date Performed:	7/25/2014	Freeway/Direction	I-26 WB
Analysis Year	2018 Build-River Center Site	Junction	WB Off to US-17 NB
Analysis Time Period:	PM Peak	Segment ID	2010
Project Description:	Navy Base ICTF		

Inputs

	Freeway Upstream of Ramp	Freeway Downstream of Ramp	Ramp
Number of Lanes, N	4	3	2
Free-Flow Speed, FFS (mph)	55	55	55
Volume, V (veh/h)	4,136	2,096	2,040
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	2%	3%	2%
%RVs, P_R	0%	0%	0%

Performance Measures

	Freeway Upstream Ramp	Freeway Downstream Ramp	Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.99	0.99	0.99
Demand Flow Rate, v_p (pc/h/ln)	1,160	788	1,145
Capacity Flow Rate, c (pc/h/ln)	2,250	2,250	2,200
v/c ratio	0.52	0.35	0.52
Density, D_{MD} (pc/mi/ln)	20.3	13.8	20.0
LOS	C	B	B

Formulas and Reference Material

$$f_{HV} = \frac{1}{1 + P_T(E_T-1)+P_R(E_R-1)}$$ HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P}$$ HCM 2010, Equation 11-2

$$D_{MD} = \frac{0.0175*v_f}{N}$$ HCM 2010, Equation 13-26

Basic Freeway Segments Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
75	2,400
70	2,400
65	2,350
60	2,300
55	2,250

Source: HCM 2010, Exhibit 11-17

Ramp Roadways Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

Diverge LOS Thresholds

LOS	Density (pc/mi/ln)
A	≤10
B	>10-20
C	>20-28
D	>28-35
E	>35
F	v/c > 1

Source: HCM 2010, Exhibit 13-2

FREEWAY RAMP ADD OR DROP LANE ANALYSIS

ATKINS

General Information

Date Performed:	3/20/2014	Freeway/Direction	I-26 WB
Analysis Year	2018 Build-River Center Site	Junction	WB Off to Romney St
Analysis Time Period:	AM Peak	Segment ID	2020
Project Description:	Navy Base ICTF		

Inputs

	Freeway Upstream of Ramp	Freeway Downstream of Ramp	Ramp
Number of Lanes, N	3	2	1
Free-Flow Speed, FFS (mph)	55	55	45
Volume, V (veh/h)	1,516	1,307	209
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	4%	3%	5%
%RVs, P_R	0%	0%	0%

Performance Measures

	Freeway Upstream Ramp	Freeway Downstream Ramp	Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.98	0.99	0.98
Demand Flow Rate, v_p (pc/h/ln)	573	737	238
Capacity Flow Rate, c (pc/h/ln)	2,250	2,250	2,100
v/c ratio	0.25	0.33	0.11
Density, D_{MD} (pc/mi/ln)	10.0	12.9	4.2
LOS	A	B	A

Formulas and Reference Material

$$f_{HV} = \frac{1}{1 + P_T(E_T-1)+P_R(E_R-1)}$$ HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P}$$ HCM 2010, Equation 11-2

$$D_{MD} = \frac{0.0175*v_f}{N}$$ HCM 2010, Equation 13-26

Basic Freeway Segments Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
75	2,400
70	2,400
65	2,350
60	2,300
55	2,250

Source: HCM 2010, Exhibit 11-17

Ramp Roadways Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

Diverge LOS Thresholds

LOS	Density (pc/mi/ln)
A	≤10
B	>10-20
C	>20-28
D	>28-35
E	>35
F	v/c > 1

Source: HCM 2010, Exhibit 13-2

FREEWAY RAMP ADD OR DROP LANE ANALYSIS

ATKINS

General Information

Date Performed:	7/25/2014	Freeway/Direction	I-26 WB
Analysis Year	2018 Build-River Center Site	Junction	WB Off to Romney St
Analysis Time Period:	PM Peak	Segment ID	2020
Project Description:	Navy Base ICTF		

Inputs

	Freeway Upstream of Ramp	Freeway Downstream of Ramp	Ramp
Number of Lanes, N	3	2	1
Free-Flow Speed, FFS (mph)	55	55	45
Volume, V (veh/h)	2,096	1,959	137
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	3%	3%	6%
%RVs, P_R	0%	0%	0%

Performance Measures

	Freeway Upstream Ramp	Freeway Downstream Ramp	Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.99	0.99	0.97
Demand Flow Rate, v_p (pc/h/ln)	788	1,105	157
Capacity Flow Rate, c (pc/h/ln)	2,250	2,250	2,100
v/c ratio	0.35	0.49	0.07
Density, D_{MD} (pc/mi/ln)	13.8	19.3	2.7
LOS	B	B	A

Formulas and Reference Material

$$f_{HV} = \frac{1}{1 + P_T(E_T-1)+P_R(E_R-1)}$$ HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P}$$ HCM 2010, Equation 11-2

$$D_{MD} = \frac{0.0175*v_f}{N}$$ HCM 2010, Equation 13-26

Basic Freeway Segments Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
75	2,400
70	2,400
65	2,350
60	2,300
55	2,250

Source: HCM 2010, Exhibit 11-17

Ramp Roadways Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

Diverge LOS Thresholds

LOS	Density (pc/mi/ln)
A	≤10
B	>10-20
C	>20-28
D	>28-35
E	>35
F	v/c > 1

Source: HCM 2010, Exhibit 13-2

BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-26 WB*
Agency or Company	*Atkins*	From/To	*2025- Romney Off to US17 SB On*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2018 Build - River Center Site*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*1307*	veh/h	Peak-Hour Factor, PHF	*0.90*	
AADT		veh/day	%Trucks and Buses, P_T	*3*	
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*	
Peak-Hr Direction Prop, D			General Terrain:	*Level*	
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*	

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.985*

Speed Inputs			Calc Speed Adj and FFS		
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f_{LW}		mph
Number of Lanes, N	*2*		f_{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	*55.0*	mph	FFS	*55.0*	mph
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures			Design (N)		
Operational (LOS)			Design (N)		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*737*	pc/h/ln	Design LOS		
S	*55.0*	mph	v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
D = v_p / S	*13.4*	pc/mi/ln	S		mph
LOS	*B*		D = v_p / S		pc/mi/ln
			Required Number of Lanes, N		

Glossary		Factor Location	
N - Number of lanes	S - Speed	E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
V - Hourly volume	D - Density	E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 11-18	TRD - Page 11-11
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 11-2, 11-3	
DDHV - Directional design hour volume			

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-26 WB*
Agency or Company	*Atkins*	From/To	*2025- Romney Off to US17 SB On*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*PM Peak*	Analysis Year	*2018 Build - River Center Site*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*1959*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*3*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.985*

Speed Inputs			Calc Speed Adj and FFS		
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f_{LW}		mph
Number of Lanes, N	*2*		f_{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	*55.0*	mph	FFS	*55.0*	mph
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures			Design (N)	
Operational (LOS)			Design (N)	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1105*	pc/h/ln	Design LOS	
			v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h/ln
S	*55.0*	mph	S	mph
D = v_p / S	*20.1*	pc/mi/ln	D = v_p / S	pc/mi/ln
LOS	*C*		Required Number of Lanes, N	

Glossary		Factor Location	
N - Number of lanes	S - Speed	E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
V - Hourly volume	D - Density	E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 11-18	TRD - Page 11-11
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 11-2, 11-3	
DDHV - Directional design hour volume			

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FREEWAY RAMP ADD OR DROP LANE ANALYSIS

ATKINS

General Information

Date Performed:	7/25/2014	Freeway/Direction	I-26 WB
Analysis Year	2018 Build-River Center Site	Junction	WB On from US-17 SB
Analysis Time Period:	AM Peak	Segment ID	2030
Project Description:	Navy Base ICTF		

Inputs

	Freeway Upstream of Ramp	Freeway Downstream of Ramp	Ramp
Number of Lanes, N	2	3	1
Free-Flow Speed, FFS (mph)	55	55	55
Volume, V (veh/h)	1,307	2,438	1,131
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	3%	3%	3%
%RVs, P_R	0%	0%	0%

Performance Measures

	Freeway Upstream Ramp	Freeway Downstream Ramp	Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.99	0.99	0.99
Demand Flow Rate, v_p (pc/h/ln)	737	917	1,276
Capacity Flow Rate, c (pc/h/ln)	2,250	2,250	2,200
v/c ratio	0.33	0.41	0.58
Density, D_{MD} (pc/mi/ln)	12.9	16.0	22.3
LOS	B	B	C

Formulas and Reference Material

$$f_{HV} = \frac{1}{1 + P_T(E_T-1)+P_R(E_R-1)}$$

HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P}$$

HCM 2010, Equation 11-2

$$D_{MD} = \frac{0.0175*v_f}{N}$$

HCM 2010, Equation 13-26

Basic Freeway Segments Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
75	2,400
70	2,400
65	2,350
60	2,300
55	2,250

Source: HCM 2010, Exhibit 11-17

Ramp Roadways Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

Diverge LOS Thresholds

LOS	Density (pc/mi/ln)
A	≤10
B	>10-20
C	>20-28
D	>28-35
E	>35
F	v/c > 1

Source: HCM 2010, Exhibit 13-2

FREEWAY RAMP ADD OR DROP LANE ANALYSIS

ATKINS

General Information

Date Performed:	7/25/2014	Freeway/Direction	I-26 WB
Analysis Year	2018 Build-River Center Site	Junction	WB On from US-17 SB
Analysis Time Period:	PM Peak	Segment ID	2030
Project Description:	Navy Base ICTF		

Inputs

	Freeway Upstream of Ramp	Freeway Downstream of Ramp	Ramp
Number of Lanes, N	2	3	1
Free-Flow Speed, FFS (mph)	55	55	55
Volume, V (veh/h)	1,959	3,094	1,135
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	3%	3%	2%
%RVs, P_R	0%	0%	0%

Performance Measures

	Freeway Upstream Ramp	Freeway Downstream Ramp	Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.99	0.99	0.99
Demand Flow Rate, v_p (pc/h/ln)	1,105	1,163	1,274
Capacity Flow Rate, c (pc/h/ln)	2,250	2,250	2,200
v/c ratio	0.49	0.52	0.58
Density, D_{MD} (pc/mi/ln)	19.3	20.4	22.3
LOS	B	C	C

Formulas and Reference Material

$$f_{HV} = \frac{1}{1 + P_T(E_T-1)+P_R(E_R-1)}$$ HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P}$$ HCM 2010, Equation 11-2

$$D_{MD} = \frac{0.0175*v_f}{N}$$ HCM 2010, Equation 13-26

Basic Freeway Segments Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
75	2,400
70	2,400
65	2,350
60	2,300
55	2,250

Source: HCM 2010, Exhibit 11-17

Ramp Roadways Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

Diverge LOS Thresholds

LOS	Density (pc/mi/ln)
A	≤10
B	>10-20
C	>20-28
D	>28-35
E	>35
F	v/c > 1

Source: HCM 2010, Exhibit 13-2

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-26 WB
Agency or Company	Atkins	Junction	2040 - WB On from Meeting
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2018 Build - River Center Site

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Freeway Number of Lanes, N	3	Downstream Adj Ramp	
☐ Yes	☐ On	Ramp Number of Lanes, N	1	☐ Yes	☐ On
☑ No	☐ Off	Acceleration Lane Length, L_A	600	☑ No	☐ Off
L_{up} =	ft	Deceleration Lane Length L_D		L_{down} =	ft
V_u =	veh/h	Freeway Volume, V_F	2438	V_D =	veh/h
		Ramp Volume, V_R	372		
		Freeway Free-Flow Speed, S_{FF}	55.0		
		Ramp Free-Flow Speed, S_{FR}	45.0		

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	2438	0.90	Level	3	0	0.985	1.00	2750
Ramp	372	0.90	Level	7	0	0.966	1.00	428
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 0.594 using Equation (Exhibit 13-6)

V_{12} = 1634 pc/h

V_3 or V_{av34} 1116 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * $V_{12}/2$ ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	3178	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	2062	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = 17.6 (pc/mi/ln)

LOS = B (Exhibit 13-2)

Speed Determination

M_S = 0.298 (Exibit 13-11)

S_R= 51.1 mph (Exhibit 13-11)

S_0= 52.8 mph (Exhibit 13-11)

S = 51.7 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * $V_{12}/2$ ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-26 WB
Agency or Company	Atkins	Junction	2040 - WB On from Meeting
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2018 Build - River Center Site

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Freeway Number of Lanes, N: 3	☐ Yes ☐ On
☑ No ☐ Off	Ramp Number of Lanes, N: 1	☑ No ☐ Off
L_{up} = ft	Acceleration Lane Length, L_A: 600	L_{down} = ft
V_u = veh/h	Deceleration Lane Length L_D:	V_D = veh/h
	Freeway Volume, V_F: 3094	
	Ramp Volume, V_R: 739	
	Freeway Free-Flow Speed, S_{FF}: 55.0	
	Ramp Free-Flow Speed, S_{FR}: 45.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	3094	0.90	Level	3	0	0.985	1.00	3489
Ramp	739	0.90	Level	3	0	0.985	1.00	833
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 0.594 using Equation (Exhibit 13-6)

V_{12} = 2074 pc/h

V_3 or V_{av34} 1415 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * $V_{12}/2$ ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	4322	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	2907	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = 24.0 (pc/mi/ln)

LOS = C (Exhibit 13-2)

Speed Determination

M_S = 0.338 (Exibit 13-11)

S_R= 50.6 mph (Exhibit 13-11)

S_0= 51.7 mph (Exhibit 13-11)

S = 51.0 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * $V_{12}/2$ ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-26 WB*
Agency or Company	*Atkins*	From/To	*2050 - Meeting to Mt Pleasant*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2018 Build - River Center Site*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*2810*	veh/h	Peak-Hour Factor, PHF	*0.90*	
AADT		veh/day	%Trucks and Buses, P_T	*3*	
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*	
Peak-Hr Direction Prop, D			General Terrain:	*Level*	
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*	

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.985*

Speed Inputs			Calc Speed Adj and FFS		
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f_{LW}		mph
Number of Lanes, N	*3*		f_{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	*55.0*	mph	FFS	*55.0*	mph
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures			Design (N)		
Operational (LOS)			Design (N)		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1056*	pc/h/ln	Design LOS		
S	*55.0*	mph	v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
D = v_p / S	*19.2*	pc/mi/ln	S		mph
LOS	*C*		D = v_p / S		pc/mi/ln
			Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-26 WB*
Agency or Company	*Atkins*	From/To	*2050 - Meeting to Mt Pleasant*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*PM Peak*	Analysis Year	*2018 Build - River Center Site*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*3833*	veh/h	Peak-Hour Factor, PHF	*0.90*	
AADT		veh/day	%Trucks and Buses, P_T	*3*	
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*	
Peak-Hr Direction Prop, D			General Terrain:	*Level*	
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*	

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.985*

Speed Inputs			Calc Speed Adj and FFS		
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f_{LW}		mph
Number of Lanes, N	*3*		f_{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	*55.0*	mph	FFS	*55.0*	mph
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures			Design (N)		
Operational (LOS)			Design (N)		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1441*	pc/h/ln	Design LOS		
S	*55.0*	mph	v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
D = v_p / S	*26.2*	pc/mi/ln	S		mph
LOS	*D*		D = v_p / S		pc/mi/ln
			Required Number of Lanes, N		

Glossary		Factor Location	
N - Number of lanes	S - Speed	E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
V - Hourly volume	D - Density	E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 11-18	TRD - Page 11-11
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 11-2, 11-3	
DDHV - Directional design hour volume			

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-26 WB
Agency or Company	Atkins	Junction	2060 - WB On from Mt Pleasant
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2018 Build - River Center Site

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Freeway Number of Lanes, N: 3	☐ Yes ☐ On
☑ No ☐ Off	Ramp Number of Lanes, N: 1	☑ No ☐ Off
L_{up} = ft	Acceleration Lane Length, L_A: 275	L_{down} = ft
V_u = veh/h	Deceleration Lane Length L_D:	V_D = veh/h
	Freeway Volume, V_F: 2810	
	Ramp Volume, V_R: 302	
	Freeway Free-Flow Speed, S_{FF}: 55.0	
	Ramp Free-Flow Speed, S_{FR}: 45.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	2810	0.90	Level	3	0	0.985	1.00	3169
Ramp	302	0.90	Level	4	0	0.980	1.00	342
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 0.585 using Equation (Exhibit 13-6)

V_{12} = 1854 pc/h

V_3 or V_{av34} 1315 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * $V_{12}/2$ ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	3511	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	2196	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = 20.7 (pc/mi/ln)

LOS = C (Exhibit 13-2)

Speed Determination

M_S = 0.331 (Exibit 13-11)

S_R= 50.7 mph (Exhibit 13-11)

S_0= 52.1 mph (Exhibit 13-11)

S = 51.2 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * $V_{12}/2$ ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-26 WB
Agency or Company	Atkins	Junction	2060 - WB On from Mt Pleasant
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2018 Build - River Center Site

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Freeway Number of Lanes, N: 3	☐ Yes ☐ On
☑ No ☐ Off	Ramp Number of Lanes, N: 1	☑ No ☐ Off
L_{up} = ft	Acceleration Lane Length, L_A: 275	L_{down} = ft
V_u = veh/h	Deceleration Lane Length L_D:	V_D = veh/h
	Freeway Volume, V_F: 3833	
	Ramp Volume, V_R: 714	
	Freeway Free-Flow Speed, S_{FF}: 55.0	
	Ramp Free-Flow Speed, S_{FR}: 45.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	3833	0.90	Level	3	0	0.985	1.00	4323
Ramp	714	0.90	Level	2	0	0.990	1.00	801
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 0.585 using Equation (Exhibit 13-6)

V_{12} = 2530 pc/h

V_3 or V_{av34} 1793 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * $V_{12}/2$ ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	5124	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	3331	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = 29.4 (pc/mi/ln)

LOS = D (Exhibit 13-2)

Speed Determination

M_S = 0.405 (Exibit 13-11)

S_R= 49.7 mph (Exhibit 13-11)

S_0= 50.3 mph (Exhibit 13-11)

S = 49.9 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * $V_{12}/2$ ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-26 WB
Agency or Company	Atkins	Junction	2070 - WB On from Heriot
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2018 Build - River Center Site

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Freeway Number of Lanes, N: 3	☐ Yes ☐ On
☑ No ☐ Off	Ramp Number of Lanes, N: 1	☑ No ☐ Off
L_{up} = ft	Acceleration Lane Length, L_A: 1165	L_{down} = ft
V_u = veh/h	Deceleration Lane Length L_D:	V_D = veh/h
	Freeway Volume, V_F: 3112	
	Ramp Volume, V_R: 251	
	Freeway Free-Flow Speed, S_{FF}: 55.0	
	Ramp Free-Flow Speed, S_{FR}: 45.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	3112	0.90	Level	4	0	0.980	1.00	3527
Ramp	251	0.90	Level	20	0	0.909	1.00	307
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 0.610 using Equation (Exhibit 13-6)

V_{12} = 2152 pc/h

V_3 or V_{av34} 1375 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * $V_{12}/2$ ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	3834	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	2459	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = 17.2 (pc/mi/ln)

LOS = B (Exhibit 13-2)

Speed Determination

M_S = 0.262 (Exibit 13-11)

S_R= 51.6 mph (Exhibit 13-11)

S_0= 51.8 mph (Exhibit 13-11)

S = 51.7 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * $V_{12}/2$ ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-26 WB
Agency or Company	Atkins	Junction	2070 - WB On from Heriot
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2018 Build - River Center Site

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Freeway Number of Lanes, N	3	Downstream Adj Ramp	
☐ Yes	☐ On	Ramp Number of Lanes, N	1	☐ Yes	☐ On
☑ No	☐ Off	Acceleration Lane Length, L_A	1165	☑ No	☐ Off
L_{up} =	ft	Deceleration Lane Length L_D		L_{down} =	ft
V_u =	veh/h	Freeway Volume, V_F	4547	V_D =	veh/h
		Ramp Volume, V_R	420		
		Freeway Free-Flow Speed, S_{FF}	55.0		
		Ramp Free-Flow Speed, S_{FR}	45.0		

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	4547	0.90	Level	3	0	0.985	1.00	5128
Ramp	420	0.90	Level	10	0	0.952	1.00	490
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 0.610 using Equation (Exhibit 13-6)

V_{12} = 3129 pc/h

V_3 or V_{av34} 1999 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * $V_{12}/2$ ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	5618	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	3619	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = 26.2 (pc/mi/ln)

LOS = C (Exhibit 13-2)

Speed Determination

M_S = 0.362 (Exibit 13-11)

S_R= 50.3 mph (Exhibit 13-11)

S_0= 49.6 mph (Exhibit 13-11)

S = 50.0 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * $V_{12}/2$ ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-26 WB*
Agency or Company	*Atkins*	From/To	*2080 - Heriot to PAR*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2018 Build - River Center Site*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*3363*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*4*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.980*

Speed Inputs			Calc Speed Adj and FFS		
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f_{LW}		mph
Number of Lanes, N	*3*		f_{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	*60.0*	mph	FFS	*60.0*	mph
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures			Design (N)	
Operational (LOS)			Design (N)	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1270*	pc/h/ln	Design LOS	
S	*60.0*	mph	v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h/ln
D = v_p / S	*21.2*	pc/mi/ln	S	mph
LOS	*C*		D = v_p / S	pc/mi/ln
			Required Number of Lanes, N	

Glossary		Factor Location	
N - Number of lanes	S - Speed	E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
V - Hourly volume	D - Density	E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 11-18	TRD - Page 11-11
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 11-2, 11-3	
DDHV - Directional design hour volume			

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-26 WB*
Agency or Company	*Atkins*	From/To	*2080 - Heriot to PAR*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*PM Peak*	Analysis Year	*2018 Build - River Center Site*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*4967*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*3*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.985*

Speed Inputs			Calc Speed Adj and FFS		
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f_{LW}		mph
Number of Lanes, N	*3*		f_{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	*60.0*	mph	FFS	*60.0*	mph
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures			Design (N)	
Operational (LOS)			Design (N)	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1867*	pc/h/ln	Design LOS	
S	*58.7*	mph	v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h/ln
D = v_p / S	*31.8*	pc/mi/ln	S	mph
LOS	*D*		D = v_p / S	pc/mi/ln
			Required Number of Lanes, N	

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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F-3853

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-26 WB
Agency or Company	Atkins	Junction	2090-WB Off to PAR
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2018 Build - River Center Site

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Freeway Number of Lanes, N: 3	☐ Yes ☐ On
☑ No ☐ Off	Ramp Number of Lanes, N: 1	☑ No ☐ Off
L_{up} = ft	Acceleration Lane Length, L_A	L_{down} = ft
V_u = veh/h	Deceleration Lane Length L_D: 340	V_D = veh/h
	Freeway Volume, V_F: 3363	
	Ramp Volume, V_R: 167	
	Freeway Free-Flow Speed, S_{FF}: 60.0	
	Ramp Free-Flow Speed, S_{FR}: 45.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	3363	0.90	Level	4	0	0.980	1.00	3811
Ramp	167	0.90	Level	3	0	0.985	1.00	188
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 0.656 using Equation (Exhibit 13-7)

V_{12} = 2565 pc/h

V_3 or V_{av34} 1246 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	3811	Exhibit 13-8	6900	No
$V_{FO} = V_F - V_R$	3623	Exhibit 13-8	6900	No
V_R	188	Exhibit 13-10	2100	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	2565	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = 23.3 (pc/mi/ln)

LOS = C (Exhibit 13-2)

Speed Determination

D_s = 0.315 (Exhibit 13-12)

S_R= 54.3 mph (Exhibit 13-12)

S_0= 64.9 mph (Exhibit 13-12)

S = 57.4 mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-26 WB
Agency or Company	Atkins	Junction	2090-WB Off to PAR
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2018 Build - River Center Site

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Freeway Number of Lanes, N: 3	☐ Yes ☐ On
☑ No ☐ Off	Ramp Number of Lanes, N: 1	☑ No ☐ Off
L_{up} = ft	Acceleration Lane Length, L_A	L_{down} = ft
V_u = veh/h	Deceleration Lane Length L_D: 340	V_D = veh/h
	Freeway Volume, V_F: 4967	
	Ramp Volume, V_R: 97	
	Freeway Free-Flow Speed, S_{FF}: 60.0	
	Ramp Free-Flow Speed, S_{FR}: 45.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	4967	0.90	Level	3	0	0.985	1.00	5602
Ramp	97	0.90	Level	2	0	0.990	1.00	109
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 0.615 using Equation (Exhibit 13-7)

V_{12} = 3487 pc/h

V_3 or V_{av34} 2115 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	5602	Exhibit 13-8	6900	No
$V_{FO} = V_F - V_R$	5493	Exhibit 13-8	6900	No
V_R	109	Exhibit 13-10	2100	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	3487	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = 31.2 (pc/mi/ln)

LOS = D (Exhibit 13-2)

Speed Determination

D_s = 0.308 (Exhibit 13-12)

S_R= 54.5 mph (Exhibit 13-12)

S_0= 61.5 mph (Exhibit 13-12)

S = 56.9 mph (Exhibit 13-13)

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-26 WB*
Agency or Company	*Atkins*	From/To	*2100 - PAR Off to PAR On*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2018 Build - River Center Site*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*3196*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*4*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.980*

Speed Inputs			Calc Speed Adj and FFS		
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f_{LW}		mph
Number of Lanes, N	*3*		f_{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	*60.0*	mph	FFS	*60.0*	mph
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures			Design (N)	
Operational (LOS)			Design (N)	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1207*	pc/h/ln	Design LOS	
S	*60.0*	mph	v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h/ln
D = v_p / S	*20.1*	pc/mi/ln	S	mph
LOS	*C*		D = v_p / S	pc/mi/ln
			Required Number of Lanes, N	

Glossary		Factor Location	
N - Number of lanes	S - Speed	E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
V - Hourly volume	D - Density	E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 11-18	TRD - Page 11-11
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 11-2, 11-3	
DDHV - Directional design hour volume			

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-26 WB*
Agency or Company	*Atkins*	From/To	*2100 - PAR Off to PAR On*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*PM Peak*	Analysis Year	*2018 Build - River Center Site*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*4870*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*3*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.985*

Speed Inputs			Calc Speed Adj and FFS		
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f_{LW}		mph
Number of Lanes, N	*3*		f_{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	*60.0*	mph	FFS	*60.0*	mph
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures			Design (N)	
Operational (LOS)			Design (N)	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1831*	pc/h/ln	Design LOS	
			v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h/ln
S	*59.0*	mph	S	mph
D = v_p / S	*31.0*	pc/mi/ln	D = v_p / S	pc/mi/ln
LOS	*D*		Required Number of Lanes, N	

Glossary		Factor Location	
N - Number of lanes	S - Speed	E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
V - Hourly volume	D - Density	E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 11-18	TRD - Page 11-11
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 11-2, 11-3	
DDHV - Directional design hour volume			

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RAMP ADD OR DROP LANE ANALYSIS (MAINLINE <55 MPH)

ATKINS

General Information

Date Performed:	3/20/2014	Freeway/Direction	WB US-52 & PAR Off Ramp
Analysis Year	2018 Build-River Center Site	Junction	US-52 & PAR WB Ramp Merge
Analysis Time Period:	AM Peak	Segment ID	2105
Project Description:	Navy Base ICTF		

Inputs

	Mainline Upstream Ramp	Mainline Downstream Ramp	Ramp
Number of Lanes, N	1	1	1
Free-Flow Speed, FFS (mph)	55	55	45
Volume, V (veh/h)	494	526	32
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	8%	8%	3%
%RVs, P_R	0%	0%	0%

Performance Measures

	Upstream of Off-Ramp	Downstream of Off-Ramp	Off-Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.96	0.96	0.99
Demand Flow Rate, v_p (pc/h/ln)	571	608	36
Capacity Flow Rate, c (pc/h/ln)	2,200	2,200	2,100
v/c ratio	0.26	0.28	0.02
Density, D_{MD} (pc/mi/ln)	10.0	10.6	0.6
LOS	A	B	A

Formulas and Reference Material

$$f_{HV} = \frac{1}{1+P_T(E_T-1)+P_R(E_R-1)}$$ HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P}$$ HCM 2010, Equation 11-2

$$D_{MD} = \frac{0.0175*v_f}{N}$$ HCM 2010, Equation 13-26

Ramp Roadways Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

Diverge LOS Thresholds

LOS	Density (pc/mi/ln)
A	≤10
B	>10-20
C	>20-28
D	>28-35
E	>35
F	v/c > 1

Source: HCM 2010, Exhibit 13-2

RAMP ADD OR DROP LANE ANALYSIS (MAINLINE <55 MPH)

ATKINS

General Information

Date Performed:	3/20/2014	Freeway/Direction	WB US-52 & PAR Off Ramp
Analysis Year	2018 Build-River Center Site	Junction	US-52 & PAR WB Ramp Merge
Analysis Time Period:	PM Peak	Segment ID	2105
Project Description:	Navy Base ICTF		

Inputs

	Mainline Upstream Ramp	Mainline Downstream Ramp	Ramp
Number of Lanes, N	1	1	1
Free-Flow Speed, FFS (mph)	55	55	45
Volume, V (veh/h)	176	264	88
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	19%	13%	2%
%RVs, P_R	0%	0%	0%

Performance Measures

	Upstream of Off-Ramp	Downstream of Off-Ramp	Off-Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.91	0.94	0.99
Demand Flow Rate, v_p (pc/h/ln)	214	312	99
Capacity Flow Rate, c (pc/h/ln)	2,200	2,200	2,100
v/c ratio	0.10	0.14	0.05
Density, D_{MD} (pc/mi/ln)	3.7	5.5	1.7
LOS	A	A	A

Formulas and Reference Material

$$f_{HV} = \frac{1}{1+P_T(E_T-1)+P_R(E_R-1)}$$ HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P}$$ HCM 2010, Equation 11-2

$$D_{MD} = \frac{0.0175*v_f}{N}$$ HCM 2010, Equation 13-26

Ramp Roadways Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

Diverge LOS Thresholds

LOS	Density (pc/mi/ln)
A	≤10
B	>10-20
C	>20-28
D	>28-35
E	>35
F	v/c > 1

Source: HCM 2010, Exhibit 13-2

RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-26 WB
Agency or Company	Atkins	Junction	2110 - WB On from US-52 & PAR
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2018 Build - River Center Site

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Freeway Number of Lanes, N	3	Downstream Adj Ramp	
☐ Yes	☐ On	Ramp Number of Lanes, N	1	☐ Yes	☐ On
☑ No	☐ Off	Acceleration Lane Length, L_A	180	☑ No	☐ Off
L_{up} =	ft	Deceleration Lane Length L_D		L_{down} =	ft
V_u =	veh/h	Freeway Volume, V_F	3196	V_D =	veh/h
		Ramp Volume, V_R	526		
		Freeway Free-Flow Speed, S_{FF}	60.0		
		Ramp Free-Flow Speed, S_{FR}	45.0		

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	3196	0.90	Level	4	0	0.980	1.00	3622
Ramp	526	0.90	Level	8	0	0.962	1.00	608
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 0.583 using Equation (Exhibit 13-6)

V_{12} = 2110 pc/h

V_3 or V_{av34} 1512 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * $V_{12}/2$ ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	4230	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	2718	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = 25.3 (pc/mi/ln)

LOS = C (Exhibit 13-2)

Speed Determination

M_S = 0.364 (Exibit 13-11)

S_R= 53.5 mph (Exhibit 13-11)

S_0= 56.4 mph (Exhibit 13-11)

S = 54.5 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * $V_{12}/2$ ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-26 WB
Agency or Company	Atkins	Junction	2110 - WB On from US-52 & PAR
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2018 Build - River Center Site

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Freeway Number of Lanes, N	3	Downstream Adj Ramp	
☐ Yes	☐ On	Ramp Number of Lanes, N	1	☐ Yes	☐ On
☑ No	☐ Off	Acceleration Lane Length, L_A	180	☑ No	☐ Off
L_{up} =	ft	Deceleration Lane Length L_D		L_{down} =	ft
V_u =	veh/h	Freeway Volume, V_F	4870	V_D =	veh/h
		Ramp Volume, V_R	264		
		Freeway Free-Flow Speed, S_{FF}	60.0		
		Ramp Free-Flow Speed, S_{FR}	45.0		

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	4870	0.90	Level	3	0	0.985	1.00	5492
Ramp	264	0.90	Level	13	0	0.939	1.00	312
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 0.583 using Equation (Exhibit 13-6)

V_{12} = 3199 pc/h

V_3 or V_{av34} 2293 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * $V_{12}/2$ ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	5804	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	3511	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = 31.6 (pc/mi/ln)

LOS = D (Exhibit 13-2)

Speed Determination

M_S = 0.435 (Exibit 13-11)

S_R= 52.2 mph (Exhibit 13-11)

S_0= 53.5 mph (Exhibit 13-11)

S = 52.7 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * $V_{12}/2$ ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-26 WB*
Agency or Company	*Atkins*	From/To	*2120 - US-52 to Cosgrove*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2018 Build - River Center Site*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*3722*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*3*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.985*

Speed Inputs			Calc Speed Adj and FFS		
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f_{LW}		mph
Number of Lanes, N	*3*		f_{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	*60.0*	mph	FFS	*60.0*	mph
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures			Design (N)	
Operational (LOS)			Design (N)	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1399*	pc/h/ln	Design LOS	
			v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h/ln
S	*60.0*	mph	S	mph
D = v_p / S	*23.3*	pc/mi/ln	D = v_p / S	pc/mi/ln
LOS	*C*		Required Number of Lanes, N	

Glossary		Factor Location	
N - Number of lanes	S - Speed	E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
V - Hourly volume	D - Density	E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 11-18	TRD - Page 11-11
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 11-2, 11-3	
DDHV - Directional design hour volume			

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-26 WB*
Agency or Company	*Atkins*	From/To	*2120 - US-52 to Cosgrove*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*PM Peak*	Analysis Year	*2018 Build - River Center Site*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*5134*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*3*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.985*

Speed Inputs			Calc Speed Adj and FFS		
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f_{LW}		mph
Number of Lanes, N	*3*		f_{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	*60.0*	mph	FFS	*60.0*	mph
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures			Design (N)	
Operational (LOS)			Design (N)	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1930*	pc/h/ln	Design LOS	
S	*58.0*	mph	v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h/ln
D = v_p / S	*33.3*	pc/mi/ln	S	mph
LOS	*D*		D = v_p / S	pc/mi/ln
			Required Number of Lanes, N	

Glossary		Factor Location	
N - Number of lanes	S - Speed	E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
V - Hourly volume	D - Density	E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 11-18	TRD - Page 11-11
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 11-2, 11-3	
DDHV - Directional design hour volume			

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-26 WB
Agency or Company	Atkins	Junction	2130-WB Off to Cosgrove NB
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2018 Build - River Center Site

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Freeway Number of Lanes, N: 3	☐ Yes ☐ On
☑ No ☐ Off	Ramp Number of Lanes, N: 1	☑ No ☐ Off
L_{up} = ft	Acceleration Lane Length, L_A	L_{down} = ft
V_u = veh/h	Deceleration Lane Length L_D: 525	V_D = veh/h
	Freeway Volume, V_F: 3722	
	Ramp Volume, V_R: 387	
	Freeway Free-Flow Speed, S_{FF}: 60.0	
	Ramp Free-Flow Speed, S_{FR}: 45.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	3722	0.90	Level	3	0	0.985	1.00	4198
Ramp	387	0.90	Level	10	0	0.952	1.00	452
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 0.634 using Equation (Exhibit 13-7)

V_{12} = 2828 pc/h

V_3 or V_{av34} 1370 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	4198	Exhibit 13-8	6900	No
$V_{FO} = V_F - V_R$	3746	Exhibit 13-8	6900	No
V_R	452	Exhibit 13-10	2100	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	2828	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = 23.8 (pc/mi/ln)

LOS = C (Exhibit 13-2)

Speed Determination

D_s = 0.339 (Exhibit 13-12)

S_R= 53.9 mph (Exhibit 13-12)

S_0= 64.4 mph (Exhibit 13-12)

S = 56.9 mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-26 WB
Agency or Company	Atkins	Junction	2130-WB Off to Cosgrove NB
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2018 Build - River Center Site

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Freeway Number of Lanes, N: 3	☐ Yes ☐ On
☑ No ☐ Off	Ramp Number of Lanes, N: 1	☑ No ☐ Off
L_{up} = ft	Acceleration Lane Length, L_A	L_{down} = ft
V_u = veh/h	Deceleration Lane Length L_D: 525	V_D = veh/h
	Freeway Volume, V_F: 5134	
	Ramp Volume, V_R: 353	
	Freeway Free-Flow Speed, S_{FF}: 60.0	
	Ramp Free-Flow Speed, S_{FR}: 45.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	5134	0.90	Level	3	0	0.985	1.00	5790
Ramp	353	0.90	Level	10	0	0.952	1.00	412
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 0.596 using Equation (Exhibit 13-7)

V_{12} = 3619 pc/h

V_3 or V_{av34} 2171 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	5790	Exhibit 13-8	6900	No
$V_{FO} = V_F - V_R$	5378	Exhibit 13-8	6900	No
V_R	412	Exhibit 13-10	2100	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	3619	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = 30.7 (pc/mi/ln)

LOS = D (Exhibit 13-2)

Speed Determination

D_s = 0.335 (Exhibit 13-12)

S_R= 54.0 mph (Exhibit 13-12)

S_0= 61.3 mph (Exhibit 13-12)

S = 56.5 mph (Exhibit 13-13)

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-26 WB*
Agency or Company	*Atkins*	From/To	*2135-Cosg NB Off to Cosg NB On*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2018 Build - River Center Site*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*3335*	veh/h	Peak-Hour Factor, PHF	*0.90*	
AADT		veh/day	%Trucks and Buses, P_T	*4*	
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*	
Peak-Hr Direction Prop, D			General Terrain:	*Level*	
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*	

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.980*

Speed Inputs			Calc Speed Adj and FFS		
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f_{LW}		mph
Number of Lanes, N	*3*		f_{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	*60.0*	mph	FFS	*60.0*	mph
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures			Design (N)		
Operational (LOS)			Design (N)		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1260*	pc/h/ln	Design LOS		
S	*60.0*	mph	v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
D = v_p / S	*21.0*	pc/mi/ln	S		mph
LOS	*C*		D = v_p / S		pc/mi/ln
			Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-26 WB*
Agency or Company	*Atkins*	From/To	*2135-Cosg NB Off to Cosg NB On*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*PM Peak*	Analysis Year	*2018 Build - River Center Site*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*4781*	veh/h	Peak-Hour Factor, PHF	*0.90*	
AADT		veh/day	%Trucks and Buses, P_T	*3*	
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*	
Peak-Hr Direction Prop, D			General Terrain:	*Level*	
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*	

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.985*

Speed Inputs			Calc Speed Adj and FFS		
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f_{LW}		mph
Number of Lanes, N	*3*		f_{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	*60.0*	mph	FFS	*60.0*	mph
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures			Design (N)	
Operational (LOS)			Design (N)	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1797*	pc/h/ln	Design LOS	
			v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h/ln
S	*59.3*	mph	S	mph
D = v_p / S	*30.3*	pc/mi/ln	D = v_p / S	pc/mi/ln
LOS	*D*		Required Number of Lanes, N	

Glossary		Factor Location	
N - Number of lanes	S - Speed	E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
V - Hourly volume	D - Density	E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 11-18	TRD - Page 11-11
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 11-2, 11-3	
DDHV - Directional design hour volume			

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Navy Base ICTF

FREEWAY WEAVING WORKSHEET

General Information

Analyst	AJR
Agency/Company	Atkins
Date Performed	7/25/2014
Analysis Time Period	AM Peak

Site Information

Freeway/Dir of Travel	I-26 WB
Weaving Segment Location	2140 - Cosgrove NB to Cos. SB
Analysis Year	2018 Build - River Center Site

Project Description *Navy Base ICTF*

Inputs

Weaving configuration	One-Sided
Weaving number of lanes, N	4
Weaving segment length, L_S	560ft
Freeway free-flow speed, FFS	60 mph
Segment type	Freeway
Freeway minimum speed, S_{MIN}	15
Freeway maximum capacity, C_{IFL}	2300
Terrain type	Level

Conversions to pc/h Under Base Conditions

	V (veh/h)	PHF	Truck (%)	RV (%)	E_T	E_R	f_{HV}	fp	v (pc/h)
V_{FF}	2962	0.90	4	0	1.5	1.2	0.980	1.00	3357
V_{RF}	859	0.90	19	0	1.5	1.2	0.913	1.00	1045
V_{FR}	373	0.90	21	0	1.5	1.2	0.905	1.00	458
V_{RR}	0	0.90	0	0	1.5	1.2	1.000	1.00	0
V_{NW}	3357							V =	4860
V_W	1503								
VR	0.309								

Configuration Characteristics

Minimum maneuver lanes, N_{WL}	2 lc	Minimum weaving lane changes, LC_{MIN}	1503 lc/h
Interchange density, ID	1.0 int/mi	Weaving lane changes, LC_W	1678 lc/h
Minimum RF lane changes, LC_{RF}	1 lc/pc	Non-weaving lane changes, LC_{NW}	225 lc/h
Minimum FR lane changes, LC_{FR}	1 lc/pc	Total lane changes, LC_{ALL}	1903 lc/h
Minimum RR lane changes, LC_{RR}	lc/pc	Non-weaving vehicle index, I_{NW}	188

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment flow rate, v	4860 pc/h	Weaving intensity factor, W	0.593
Weaving segment capacity, c_w	7482 veh/h	Weaving segment speed, S	43.3 mph
Weaving segment v/c ratio	0.637	Average weaving speed, S_W	43.2 mph
Weaving segment density, D	28.1 pc/mi/ln	Average non-weaving speed, S_{NW}	43.3 mph
Level of Service, LOS	D	Maximum weaving length, L_{MAX}	5683 ft

Notes

a. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments".
b. For volumes that exceed the weaving segment capacity, the level of service is "F".

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Navy Base ICTF

FREEWAY WEAVING WORKSHEET

General Information

Analyst	AJR
Agency/Company	Atkins
Date Performed	7/25/2014
Analysis Time Period	PM Peak

Site Information

Freeway/Dir of Travel	I-26 WB
Weaving Segment Location	2140 - Cosgrove NB to Cos. SB
Analysis Year	2018 Build - River Center Site

Project Description *Navy Base ICTF*

Inputs

Weaving configuration	One-Sided
Weaving number of lanes, N	4
Weaving segment length, L_S	560ft
Freeway free-flow speed, FFS	60 mph
Segment type	Freeway
Freeway minimum speed, S_{MIN}	15
Freeway maximum capacity, C_{IFL}	2300
Terrain type	Level

Conversions to pc/h Under Base Conditions

	V (veh/h)	PHF	Truck (%)	RV (%)	E_T	E_R	f_{HV}	f_p	v (pc/h)
V_{FF}	3948	0.90	3	0	1.5	1.2	0.985	1.00	4452
V_{RF}	785	0.90	18	0	1.5	1.2	0.917	1.00	951
V_{FR}	833	0.90	8	0	1.5	1.2	0.962	1.00	963
V_{RR}	0	0.90	0	0	1.5	1.2	1.000	1.00	0
V_{NW}	4452							V =	6366
V_W	1914								
VR	0.301								

Configuration Characteristics

Minimum maneuver lanes, N_{WL}	2 lc	Minimum weaving lane changes, LC_{MIN}	1914 lc/h
Interchange density, ID	1.0 int/mi	Weaving lane changes, LC_W	2089 lc/h
Minimum RF lane changes, LC_{RF}	1 lc/pc	Non-weaving lane changes, LC_{NW}	450 lc/h
Minimum FR lane changes, LC_{FR}	1 lc/pc	Total lane changes, LC_{ALL}	2539 lc/h
Minimum RR lane changes, LC_{RR}	lc/pc	Non-weaving vehicle index, I_{NW}	249

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment flow rate, v	6366 pc/h	Weaving intensity factor, W	0.745
Weaving segment capacity, c_w	7547 veh/h	Weaving segment speed, S	39.2 mph
Weaving segment v/c ratio	0.831	Average weaving speed, S_W	40.8 mph
Weaving segment density, D	40.6 pc/mi/ln	Average non-weaving speed, S_{NW}	38.6 mph
Level of Service, LOS	E	Maximum weaving length, L_{MAX}	5591 ft

Notes

a. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments".
b. For volumes that exceed the weaving segment capacity, the level of service is "F".

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-26 WB*
Agency or Company	*Atkins*	From/To	*2145-Cosg SB Off to Cosg SB On*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2018 Build - River Center Site*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*3821*	veh/h	Peak-Hour Factor, PHF	*0.90*	
AADT		veh/day	%Trucks and Buses, P_T	*4*	
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*	
Peak-Hr Direction Prop, D			General Terrain:	*Level*	
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*	

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.980*

Speed Inputs			Calc Speed Adj and FFS		
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f_{LW}		mph
Number of Lanes, N	*3*		f_{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	*60.0*	mph	FFS	*60.0*	mph
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures			Design (N)		
Operational (LOS)			Design (N)		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1443*	pc/h/ln	Design LOS		
S	*60.0*	mph	v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
D = v_p / S	*24.0*	pc/mi/ln	S		mph
LOS	*C*		D = v_p / S		pc/mi/ln
			Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-26 WB*
Agency or Company	*Atkins*	From/To	*2145-Cosg SB Off to Cosg SB On*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*PM Peak*	Analysis Year	*2018 Build - River Center Site*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*4733*	veh/h	Peak-Hour Factor, PHF	*0.90*	
AADT		veh/day	%Trucks and Buses, P_T	*3*	
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*	
Peak-Hr Direction Prop, D			General Terrain:	*Level*	
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*	

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.985*

Speed Inputs			Calc Speed Adj and FFS		
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f_{LW}		mph
Number of Lanes, N	*3*		f_{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	*60.0*	mph	FFS	*60.0*	mph
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures			Design (N)		
Operational (LOS)			Design (N)		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1779*	pc/h/ln	Design LOS		
S	*59.4*	mph	v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
D = v_p / S	*29.9*	pc/mi/ln	S		mph
LOS	*D*		D = v_p / S		pc/mi/ln
			Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-26 WB
Agency or Company	Atkins	Junction	2150 - WB On from Cosgrove SB
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2018 Build - River Center Site

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Freeway Number of Lanes, N: 3	☑ Yes ☐ On
☑ No ☐ Off	Ramp Number of Lanes, N: 1	☐ No ☑ Off
L_{up} = ft	Acceleration Lane Length, L_A: 425	L_{down} = 2390 ft
V_u = veh/h	Deceleration Lane Length L_D:	V_D = 352 veh/h
	Freeway Volume, V_F: 3821	
	Ramp Volume, V_R: 161	
	Freeway Free-Flow Speed, S_{FF}: 60.0	
	Ramp Free-Flow Speed, S_{FR}: 45.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	3821	0.90	Level	4	0	0.980	1.00	4330
Ramp	161	0.90	Level	20	0	0.909	1.00	197
UpStream								
DownStream	352	0.90	Level	19	0	0.913	1.00	428

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = 2759.95 (Equation 13-6 or 13-7)

P_{FM} = 0.596 using Equation (Exhibit 13-6)

V_{12} = 2580 pc/h

V_3 or V_{av34} 1750 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * $V_{12}/2$ ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	4527	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	2777	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = 24.4 (pc/mi/ln)

LOS = C (Exhibit 13-2)

Speed Determination

M_S = 0.345 (Exibit 13-11)

S_R= 53.8 mph (Exhibit 13-11)

S_0= 55.5 mph (Exhibit 13-11)

S = 54.4 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * $V_{12}/2$ ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-26 WB
Agency or Company	Atkins	Junction	2150 - WB On from Cosgrove SB
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2018 Build - River Center Site

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Freeway Number of Lanes, N: 3	☑ Yes ☐ On
☑ No ☐ Off	Ramp Number of Lanes, N: 1	☐ No ☑ Off
L_{up} = ft	Acceleration Lane Length, L_A: 425	L_{down} = 2390 ft
V_u = veh/h	Deceleration Lane Length L_D:	V_D = 414 veh/h
	Freeway Volume, V_F: 4733	
	Ramp Volume, V_R: 344	
	Freeway Free-Flow Speed, S_{FF}: 60.0	
	Ramp Free-Flow Speed, S_{FR}: 45.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	4733	0.90	Level	3	0	0.985	1.00	5338
Ramp	344	0.90	Level	8	0	0.962	1.00	398
UpStream								
DownStream	414	0.90	Level	14	0	0.935	1.00	492

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = 3172.66 (Equation 13-6 or 13-7)

P_{FM} = 0.603 using Equation (Exhibit 13-6)

V_{12} = 3218 pc/h

V_3 or V_{av34} 2120 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * $V_{12}/2$ ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	5736	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	3616	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = 30.8 (pc/mi/ln)

LOS = D (Exhibit 13-2)

Speed Determination

M_S = 0.428 (Exibit 13-11)

S_R= 52.3 mph (Exhibit 13-11)

S_0= 54.2 mph (Exhibit 13-11)

S = 53.0 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * $V_{12}/2$ ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-26 WB
Agency or Company	Atkins	Junction	2160-WB Off to Dorchester
Date Performed	3/20/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2018 Build - River Center Site

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp

☑ Yes ☑ On

☐ No ☐ Off

L_{up} = 2390 ft

V_u = 161 veh/h

Freeway Number of Lanes, N	3
Ramp Number of Lanes, N	1
Acceleration Lane Length, L_A	
Deceleration Lane Length L_D	425
Freeway Volume, V_F	3982
Ramp Volume, V_R	352
Freeway Free-Flow Speed, S_{FF}	60.0
Ramp Free-Flow Speed, S_{FR}	45.0

Downstream Adj Ramp

☐ Yes ☐ On

☑ No ☐ Off

L_{down} = ft

V_D = veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	3982	0.90	Level	4	0	0.980	1.00	4513
Ramp	352	0.90	Level	19	0	0.913	1.00	428
UpStream	161	0.90	Level	20	0	0.909	1.00	197
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = 1384.68 (Equation 13-12 or 13-13)

P_{FD} = 0.627 using Equation (Exhibit 13-7)

V_{12} = 2991 pc/h

V_3 or V_{av34} 1522 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	4513	Exhibit 13-8	6900	No
$V_{FO} = V_F - V_R$	4085	Exhibit 13-8	6900	No
V_R	428	Exhibit 13-10	2100	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	2991	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = 26.1 (pc/mi/ln)

LOS = C (Exhibit 13-2)

Speed Determination

D_s = 0.337 (Exhibit 13-12)

S_R= 53.9 mph (Exhibit 13-12)

S_0= 63.8 mph (Exhibit 13-12)

S = 56.9 mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-26 WB
Agency or Company	Atkins	Junction	2160-WB Off to Dorchester
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2018 Build - River Center Site

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp

☑ Yes ☑ On

☐ No ☐ Off

L_{up} = 2390 ft

V_u = 344 veh/h

Freeway Number of Lanes, N	3
Ramp Number of Lanes, N	1
Acceleration Lane Length, L_A	
Deceleration Lane Length L_D	425
Freeway Volume, V_F	5077
Ramp Volume, V_R	414
Freeway Free-Flow Speed, S_{FF}	60.0
Ramp Free-Flow Speed, S_{FR}	45.0

Downstream Adj Ramp

☐ Yes ☐ On

☑ No ☐ Off

L_{down} = ft

V_D = veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	5077	0.90	Level	3	0	0.985	1.00	5726
Ramp	414	0.90	Level	14	0	0.935	1.00	492
UpStream	344	0.90	Level	8	0	0.962	1.00	398
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = 2407.66 (Equation 13-12 or 13-13)

P_{FD} = 0.594 using Equation (Exhibit 13-7)

V_{12} = 3602 pc/h

V_3 or V_{av34} 2124 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	5726	Exhibit 13-8	6900	No
$V_{FO} = V_F - V_R$	5234	Exhibit 13-8	6900	No
V_R	492	Exhibit 13-10	2100	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	3602	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = 31.4 (pc/mi/ln)

LOS = D (Exhibit 13-2)

Speed Determination

D_s = 0.342 (Exhibit 13-12)

S_R= 53.8 mph (Exhibit 13-12)

S_0= 61.4 mph (Exhibit 13-12)

S = 56.4 mph (Exhibit 13-13)

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-26 WB*
Agency or Company	*Atkins*	From/To	*2165-Dorches Off to Dorches On*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2018 Build - River Center Site*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*3630*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*4*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.980*

Speed Inputs			Calc Speed Adj and FFS		
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f_{LW}		mph
Number of Lanes, N	*3*		f_{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	*60.0*	mph	FFS	*60.0*	mph
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures			Design (N)	
Operational (LOS)			Design (N)	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1371*	pc/h/ln	Design LOS	
S	*60.0*	mph	v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h/ln
D = v_p / S	*22.9*	pc/mi/ln	S	mph
LOS	*C*		D = v_p / S	pc/mi/ln
			Required Number of Lanes, N	

Glossary		Factor Location	
N - Number of lanes	S - Speed	E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
V - Hourly volume	D - Density	E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 11-18	TRD - Page 11-11
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 11-2, 11-3	
DDHV - Directional design hour volume			

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F-3876

BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-26 WB*
Agency or Company	*Atkins*	From/To	*2165-Dorches Off to Dorches On*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*PM Peak*	Analysis Year	*2018 Build - River Center Site*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*4663*	veh/h	Peak-Hour Factor, PHF	*0.90*	
AADT		veh/day	%Trucks and Buses, P_T	*3*	
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*	
Peak-Hr Direction Prop, D			General Terrain:	*Level*	
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*	

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.985*

Speed Inputs			Calc Speed Adj and FFS		
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f_{LW}		mph
Number of Lanes, N	*3*		f_{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	*60.0*	mph	FFS	*60.0*	mph
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures			Design (N)	
Operational (LOS)			Design (N)	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1753*	pc/h/ln	Design LOS	
			v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h/ln
S	*59.6*	mph	S	mph
D = v_p / S	*29.4*	pc/mi/ln	D = v_p / S	pc/mi/ln
LOS	*D*		Required Number of Lanes, N	

Glossary		Factor Location	
N - Number of lanes	S - Speed	E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
V - Hourly volume	D - Density	E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 11-18	TRD - Page 11-11
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 11-2, 11-3	
DDHV - Directional design hour volume			

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-26 WB
Agency or Company	Atkins	Junction	2170 - WB On from Dorchester
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2018 Build - River Center Site

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Freeway Number of Lanes, N	3	Downstream Adj Ramp	
☐ Yes	☐ On	Ramp Number of Lanes, N	1	☐ Yes	☐ On
☑ No	☐ Off	Acceleration Lane Length, L_A	600	☑ No	☐ Off
L_{up} =	ft	Deceleration Lane Length L_D		L_{down} =	ft
V_u =	veh/h	Freeway Volume, V_F	3630	V_D =	veh/h
		Ramp Volume, V_R	253		
		Freeway Free-Flow Speed, S_{FF}	60.0		
		Ramp Free-Flow Speed, S_{FR}	45.0		

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	3630	0.90	Level	4	0	0.980	1.00	4114
Ramp	253	0.90	Level	25	0	0.889	1.00	316
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 0.594 using Equation (Exhibit 13-6)

V_{12} = 2445 pc/h

V_3 or V_{av34} 1669 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * $V_{12}/2$ ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	4430	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	2761	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = 23.1 (pc/mi/ln)

LOS = C (Exhibit 13-2)

Speed Determination

M_S = 0.329 (Exibit 13-11)

S_R= 54.1 mph (Exhibit 13-11)

S_0= 55.8 mph (Exhibit 13-11)

S = 54.7 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * $V_{12}/2$ ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-26 WB
Agency or Company	Atkins	Junction	2170 - WB On from Dorchester
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2018 Build - River Center Site

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Downstream Adj Ramp
☐ Yes ☐ On	Freeway Number of Lanes, N: 3	☐ Yes ☐ On
☑ No ☐ Off	Ramp Number of Lanes, N: 1	☑ No ☐ Off
L_{up} = ft	Acceleration Lane Length, L_A: 600	L_{down} = ft
V_u = veh/h	Deceleration Lane Length L_D	V_D = veh/h
	Freeway Volume, V_F: 4663	
	Ramp Volume, V_R: 552	
	Freeway Free-Flow Speed, S_{FF}: 60.0	
	Ramp Free-Flow Speed, S_{FR}: 45.0	

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	4663	0.90	Level	3	0	0.985	1.00	5259
Ramp	552	0.90	Level	10	0	0.952	1.00	644
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = 0.594 using Equation (Exhibit 13-6)

V_{12} = 3125 pc/h

V_3 or V_{av34} 2134 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * $V_{12}/2$ ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}	5903	Exhibit 13-8		No

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}	3769	Exhibit 13-8	4600:All	No

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = 30.8 (pc/mi/ln)

LOS = D (Exhibit 13-2)

Speed Determination

M_S = 0.436 (Exibit 13-11)

S_R= 52.2 mph (Exhibit 13-11)

S_0= 54.1 mph (Exhibit 13-11)

S = 52.8 mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = using Equation (Exhibit 13-7)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * $V_{12}/2$ ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F		Exhibit 13-8		
$V_{FO} = V_F - V_R$		Exhibit 13-8		
V_R		Exhibit 13-10		

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

D_s = (Exhibit 13-12)

S_R= mph (Exhibit 13-12)

S_0= mph (Exhibit 13-12)

S = mph (Exhibit 13-13)

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-26 WB*
Agency or Company	*Atkins*	From/To	*2180 - Dorchester to Montague*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2018 Build - River Center Site*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*3883*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*3*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.985*

Speed Inputs			Calc Speed Adj and FFS		
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f_{LW}		mph
Number of Lanes, N	*3*		f_{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	*60.0*	mph	FFS	*60.0*	mph
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures			Design (N)	
Operational (LOS)			Design (N)	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1460*	pc/h/ln	Design LOS	
			v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h/ln
S	*60.0*	mph	S	mph
D = v_p / S	*24.3*	pc/mi/ln	D = v_p / S	pc/mi/ln
LOS	*C*		Required Number of Lanes, N	

Glossary		Factor Location	
N - Number of lanes	S - Speed	E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
V - Hourly volume	D - Density	E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 11-18	TRD - Page 11-11
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 11-2, 11-3	
DDHV - Directional design hour volume			

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-26 WB*
Agency or Company	*Atkins*	From/To	*2180 - Dorchester to Montague*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*PM Peak*	Analysis Year	*2018 Build - River Center Site*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*5215*	veh/h	Peak-Hour Factor, PHF	*0.90*	
AADT		veh/day	%Trucks and Buses, P_T	*3*	
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*	
Peak-Hr Direction Prop, D			General Terrain:	*Level*	
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*	

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.985*

Speed Inputs			Calc Speed Adj and FFS		
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f_{LW}		mph
Number of Lanes, N	*3*		f_{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	*60.0*	mph	FFS	*60.0*	mph
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures			Design (N)	
Operational (LOS)			Design (N)	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1960*	pc/h/ln	Design LOS	
S	*57.6*	mph	v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h/ln
D = v_p / S	*34.0*	pc/mi/ln	S	mph
LOS	*D*		D = v_p / S	pc/mi/ln
			Required Number of Lanes, N	

Glossary		Factor Location	
N - Number of lanes	S - Speed	E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
V - Hourly volume	D - Density	E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 11-18	TRD - Page 11-11
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 11-2, 11-3	
DDHV - Directional design hour volume			

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-26 WB
Agency or Company	Atkins	Junction	2190-WB Off to Montague
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2018 Build - River Center Site

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Freeway Number of Lanes, N	3	Downstream Adj Ramp	
☐ Yes	☐ On	Ramp Number of Lanes, N	1	☐ Yes	☐ On
☑ No	☐ Off	Acceleration Lane Length, L_A		☑ No	☐ Off
L_{up} =	ft	Deceleration Lane Length L_D	240	L_{down} =	ft
V_u =	veh/h	Freeway Volume, V_F	3883	V_D =	veh/h
		Ramp Volume, V_R	995		
		Freeway Free-Flow Speed, S_{FF}	60.0		
		Ramp Free-Flow Speed, S_{FR}	45.0		

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	3883	0.90	Level	3	0	0.985	1.00	4379
Ramp	995	0.90	Level	10	0	0.952	1.00	1161
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 0.597 using Equation (Exhibit 13-7)

V_{12} = 3083 pc/h

V_3 or V_{av34} 1296 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	4379	Exhibit 13-8	6900	No
$V_{FO} = V_F - V_R$	3218	Exhibit 13-8	6900	No
V_R	1161	Exhibit 13-10	2100	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	3083	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = 28.6 (pc/mi/ln)

LOS = D (Exhibit 13-2)

Speed Determination

D_s = 0.402 (Exhibit 13-12)

S_R= 52.8 mph (Exhibit 13-12)

S_0= 64.7 mph (Exhibit 13-12)

S = 55.8 mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-26 WB
Agency or Company	Atkins	Junction	2190-WB Off to Montague
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2018 Build - River Center Site

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp

☐ Yes ☐ On

☑ No ☐ Off

L_{up} = ft

V_u = veh/h

Freeway Number of Lanes, N	3
Ramp Number of Lanes, N	1
Acceleration Lane Length, L_A	
Deceleration Lane Length L_D	240
Freeway Volume, V_F	5215
Ramp Volume, V_R	1008
Freeway Free-Flow Speed, S_{FF}	60.0
Ramp Free-Flow Speed, S_{FR}	45.0

Downstream Adj Ramp

☐ Yes ☐ On

☑ No ☐ Off

L_{down} = ft

V_D = veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	5215	0.90	Level	3	0	0.985	1.00	5881
Ramp	1008	0.90	Level	8	0	0.962	1.00	1165
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 0.559 using Equation (Exhibit 13-7)

V_{12} = 3803 pc/h

V_3 or V_{av34} 2078 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	5881	Exhibit 13-8	6900	No
$V_{FO} = V_F - V_R$	4716	Exhibit 13-8	6900	No
V_R	1165	Exhibit 13-10	2100	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	3803	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = 34.8 (pc/mi/ln)

LOS = D (Exhibit 13-2)

Speed Determination

D_s = 0.403 (Exhibit 13-12)

S_R= 52.7 mph (Exhibit 13-12)

S_0= 61.6 mph (Exhibit 13-12)

S = 55.6 mph (Exhibit 13-13)

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-26 WB*
Agency or Company	*Atkins*	From/To	*2195-Montagu Off to Montagu On*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2018 Build - River Center Site*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*2888*	veh/h	Peak-Hour Factor, PHF	*0.90*	
AADT		veh/day	%Trucks and Buses, P_T	*4*	
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*	
Peak-Hr Direction Prop, D			General Terrain:	*Level*	
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*	

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.980*

Speed Inputs			Calc Speed Adj and FFS		
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f_{LW}		mph
Number of Lanes, N	*3*		f_{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	*60.0*	mph	FFS	*60.0*	mph
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures			Design (N)		
Operational (LOS)			Design (N)		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1091*	pc/h/ln	Design LOS		
			v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S	*60.0*	mph	S		mph
D = v_p / S	*18.2*	pc/mi/ln	D = v_p / S		pc/mi/ln
LOS	*C*		Required Number of Lanes, N		

Glossary		Factor Location	
N - Number of lanes	S - Speed	E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
V - Hourly volume	D - Density	E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 11-18	TRD - Page 11-11
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 11-2, 11-3	
DDHV - Directional design hour volume			

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-26 WB*
Agency or Company	*Atkins*	From/To	*2195-Montagu Off to Montagu On*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*PM Peak*	Analysis Year	*2018 Build - River Center Site*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*4207*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*3*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.985*

Speed Inputs			Calc Speed Adj and FFS		
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f_{LW}		mph
Number of Lanes, N	*3*		f_{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	*60.0*	mph	FFS	*60.0*	mph
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures			Design (N)		
Operational (LOS)			Design (N)		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1582*	pc/h/ln	Design LOS		
			v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S	*60.0*	mph	S		mph
D = v_p / S	*26.4*	pc/mi/ln	D = v_p / S		pc/mi/ln
LOS	*D*		Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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Navy Base ICTF

FREEWAY WEAVING WORKSHEET

General Information

Analyst	AJR
Agency/Company	Atkins
Date Performed	7/25/2014
Analysis Time Period	AM Peak

Site Information

Freeway/Dir of Travel	I-26 WB
Weaving Segment Location	2200 - Montague to I-526 EB
Analysis Year	2018 Build - River Center Site

Project Description *Navy Base ICTF*

Inputs

Weaving configuration	One-Sided	Segment type	Freeway
Weaving number of lanes, N	4	Freeway minimum speed, S_{MIN}	15
Weaving segment length, L_S	1920ft	Freeway maximum capacity, C_{IFL}	2300
Freeway free-flow speed, FFS	60 mph	Terrain type	Level

Conversions to pc/h Under Base Conditions

	V (veh/h)	PHF	Truck (%)	RV (%)	E_T	E_R	f_{HV}	f_p	v (pc/h)
V_{FF}	2451	0.90	4	0	1.5	1.2	0.980	1.00	2778
V_{RF}	348	0.90	22	0	1.5	1.2	0.901	1.00	429
V_{FR}	437	0.90	8	0	1.5	1.2	0.962	1.00	505
V_{RR}	62	0.90	22	0	1.5	1.2	0.901	1.00	76
V_{NW}	2854							V =	3788
V_W	934								
VR	0.247								

Configuration Characteristics

Minimum maneuver lanes, N_{WL}	2 lc	Minimum weaving lane changes, LC_{MIN}	934 lc/h
Interchange density, ID	0.8 int/mi	Weaving lane changes, LC_W	1336 lc/h
Minimum RF lane changes, LC_{RF}	1 lc/pc	Non-weaving lane changes, LC_{NW}	858 lc/h
Minimum FR lane changes, LC_{FR}	1 lc/pc	Total lane changes, LC_{ALL}	2194 lc/h
Minimum RR lane changes, LC_{RR}	lc/pc	Non-weaving vehicle index, I_{NW}	438

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment flow rate, v	3788 pc/h	Weaving intensity factor, W	0.251
Weaving segment capacity, c_w	8090 veh/h	Weaving segment speed, S	49.3 mph
Weaving segment v/c ratio	0.459	Average weaving speed, S_W	51.0 mph
Weaving segment density, D	19.2 pc/mi/ln	Average non-weaving speed, S_{NW}	48.7 mph
Level of Service, LOS	B	Maximum weaving length, L_{MAX}	5018 ft

Notes

a. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments".
b. For volumes that exceed the weaving segment capacity, the level of service is "F".

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Navy Base ICTF

FREEWAY WEAVING WORKSHEET

General Information

Analyst	AJR
Agency/Company	Atkins
Date Performed	7/25/2014
Analysis Time Period	PM Peak

Site Information

Freeway/Dir of Travel	I-26 WB
Weaving Segment Location	2200 - Montague to I-526 EB
Analysis Year	2018 Build - River Center Site

Project Description *Navy Base ICTF*

Inputs

Weaving configuration	One-Sided
Weaving number of lanes, N	4
Weaving segment length, L_S	1920ft
Freeway free-flow speed, FFS	60 mph
Segment type	Freeway
Freeway minimum speed, S_{MIN}	15
Freeway maximum capacity, C_{IFL}	2300
Terrain type	Level

Conversions to pc/h Under Base Conditions

	V (veh/h)	PHF	Truck (%)	RV (%)	E_T	E_R	f_{HV}	fp	v (pc/h)
V_{FF}	3853	0.90	3	0	1.5	1.2	0.985	1.00	4345
V_{RF}	1039	0.90	7	0	1.5	1.2	0.966	1.00	1195
V_{FR}	354	0.90	8	0	1.5	1.2	0.962	1.00	409
V_{RR}	95	0.90	8	0	1.5	1.2	0.962	1.00	110
V_{NW}	4455							V =	6059
V_W	1604								
VR	0.265								

Configuration Characteristics

Minimum maneuver lanes, N_{WL}	2 lc	Minimum weaving lane changes, LC_{MIN}	1604 lc/h
Interchange density, ID	0.8 int/mi	Weaving lane changes, LC_W	2006 lc/h
Minimum RF lane changes, LC_{RF}	1 lc/pc	Non-weaving lane changes, LC_{NW}	1188 lc/h
Minimum FR lane changes, LC_{FR}	1 lc/pc	Total lane changes, LC_{ALL}	3194 lc/h
Minimum RR lane changes, LC_{RR}	lc/pc	Non-weaving vehicle index, I_{NW}	684

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment flow rate, v	6059 pc/h	Weaving intensity factor, W	0.338
Weaving segment capacity, c_w	8071 veh/h	Weaving segment speed, S	42.9 mph
Weaving segment v/c ratio	0.740	Average weaving speed, S_W	48.6 mph
Weaving segment density, D	35.3 pc/mi/ln	Average non-weaving speed, S_{NW}	41.2 mph
Level of Service, LOS	E	Maximum weaving length, L_{MAX}	5209 ft

Notes

a. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments".
b. For volumes that exceed the weaving segment capacity, the level of service is "F".

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-26 WB
Agency or Company	Atkins	Junction	2210-WB Off to I-526 WB
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	AM Peak	Analysis Year	2018 Build - River Center Site

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp

☐ Yes ☐ On

☑ No ☐ Off

L_{up} = ft

V_u = veh/h

Freeway Number of Lanes, N	3
Ramp Number of Lanes, N	1
Acceleration Lane Length, L_A	
Deceleration Lane Length L_D	830
Freeway Volume, V_F	2799
Ramp Volume, V_R	275
Freeway Free-Flow Speed, S_{FF}	60.0
Ramp Free-Flow Speed, S_{FR}	25.0

Downstream Adj Ramp

☐ Yes ☐ On

☑ No ☐ Off

L_{down} = ft

V_D = veh/h

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	2799	0.90	Level	12	0	0.943	1.00	3297
Ramp	275	0.90	Level	7	0	0.966	1.00	316
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 0.663 using Equation (Exhibit 13-7)

V_{12} = 2293 pc/h

V_3 or V_{av34} 1004 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	3297	Exhibit 13-8	6900	No
$V_{FO} = V_F - V_R$	2981	Exhibit 13-8	6900	No
V_R	316	Exhibit 13-10	1900	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	2293	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = 16.5 (pc/mi/ln)

LOS = B (Exhibit 13-2)

Speed Determination

D_s = 0.586 (Exhibit 13-12)

S_R= 49.4 mph (Exhibit 13-12)

S_0= 65.8 mph (Exhibit 13-12)

S = 53.5 mph (Exhibit 13-13)

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RAMPS AND RAMP JUNCTIONS WORKSHEET

General Information / Site Information

Analyst	AJR	Freeway/Dir of Travel	I-26 WB
Agency or Company	Atkins	Junction	2210-WB Off to I-526 WB
Date Performed	7/25/2014	Jurisdiction	
Analysis Time Period	PM Peak	Analysis Year	2018 Build - River Center Site

Project Description Navy Base ICTF

Inputs

Upstream Adj Ramp		Freeway Number of Lanes, N	3	Downstream Adj Ramp	
☐ Yes	☐ On	Ramp Number of Lanes, N	1	☐ Yes	☐ On
☑ No	☐ Off	Acceleration Lane Length, L_A		☑ No	☐ Off
L_{up} =	ft	Deceleration Lane Length L_D	830	L_{down} =	ft
V_u =	veh/h	Freeway Volume, V_F	4892	V_D =	veh/h
		Ramp Volume, V_R	338		
		Freeway Free-Flow Speed, S_{FF}	60.0		
		Ramp Free-Flow Speed, S_{FR}	25.0		

Conversion to pc/h Under Base Conditions

(pc/h)	V (Veh/hr)	PHF	Terrain	%Truck	%Rv	f_{HV}	f_p	$v = V/PHF \times f_{HV} \times f_p$
Freeway	4892	0.90	Level	10	0	0.952	1.00	5707
Ramp	338	0.90	Level	5	0	0.976	1.00	385
UpStream								
DownStream								

Merge Areas

Estimation of v_{12}

$V_{12} = V_F (P_{FM})$

L_{EQ} = (Equation 13-6 or 13-7)

P_{FM} = using Equation (Exhibit 13-6)

V_{12} = pc/h

V_3 or V_{av34} pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☐ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☐ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_{FO}		Exhibit 13-8		

Flow Entering Merge Influence Area

	Actual	Max Desirable		Violation?
V_{R12}		Exhibit 13-8		

Level of Service Determination (if not F)

$D_R = 5.475 + 0.00734\, v_R + 0.0078\, V_{12} - 0.00627\, L_A$

D_R = (pc/mi/ln)

LOS = (Exhibit 13-2)

Speed Determination

M_S = (Exibit 13-11)

S_R= mph (Exhibit 13-11)

S_0= mph (Exhibit 13-11)

S = mph (Exhibit 13-13)

Diverge Areas

Estimation of v_{12}

$V_{12} = V_R + (V_F - V_R)P_{FD}$

L_{EQ} = (Equation 13-12 or 13-13)

P_{FD} = 0.600 using Equation (Exhibit 13-7)

V_{12} = 3576 pc/h

V_3 or V_{av34} 2131 pc/h (Equation 13-14 or 13-17)

Is V_3 or V_{av34} > 2,700 pc/h? ☐ Yes ☑ No

Is V_3 or V_{av34} > 1.5 * V_{12}/2 ☐ Yes ☑ No

If Yes, V_{12a} = pc/h (Equation 13-16, 13-18, or 13-19)

Capacity Checks

	Actual	Capacity		LOS F?
V_F	5707	Exhibit 13-8	6900	No
$V_{FO} = V_F - V_R$	5322	Exhibit 13-8	6900	No
V_R	385	Exhibit 13-10	1900	No

Flow Entering Diverge Influence Area

	Actual	Max Desirable		Violation?
V_{12}	3576	Exhibit 13-8	4400:All	No

Level of Service Determination (if not F)

$D_R = 4.252 + 0.0086\, V_{12} - 0.009\, L_D$

D_R = 27.5 (pc/mi/ln)

LOS = C (Exhibit 13-2)

Speed Determination

D_s = 0.593 (Exhibit 13-12)

S_R= 49.3 mph (Exhibit 13-12)

S_0= 61.4 mph (Exhibit 13-12)

S = 53.2 mph (Exhibit 13-13)

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-26 WB*
Agency or Company	*Atkins*	From/To	*2215- I-526 WB Off to EB&WB On*
Date Performed	*4/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2018 Build - River Center Site*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*2524*	veh/h	Peak-Hour Factor, PHF	*0.90*	
AADT		veh/day	%Trucks and Buses, P_T	*12*	
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*	
Peak-Hr Direction Prop, D			General Terrain:	*Level*	
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*	

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.943*

Speed Inputs			Calc Speed Adj and FFS		
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f_{LW}		mph
Number of Lanes, N	*3*		f_{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	*60.0*	mph	FFS	*60.0*	mph
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures			Design (N)		
Operational (LOS)			Design (N)		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*991*	pc/h/ln	Design LOS		
S	*60.0*	mph	v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
D = v_p / S	*16.5*	pc/mi/ln	S		mph
LOS	*B*		D = v_p / S		pc/mi/ln
			Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-26 WB*
Agency or Company	*Atkins*	From/To	*2215- I-526 WB Off to EB&WB On*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*PM Peak*	Analysis Year	*2018 Build - River Center Site*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*4554*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*10*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.952*

Speed Inputs			Calc Speed Adj and FFS		
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f_{LW}		mph
Number of Lanes, N	*3*		f_{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	*60.0*	mph	FFS	*60.0*	mph
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures			Design (N)	
Operational (LOS)			Design (N)	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1771*	pc/h/ln	Design LOS	
			v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h/ln
S	*59.5*	mph	S	mph
D = v_p / S	*29.8*	pc/mi/ln	D = v_p / S	pc/mi/ln
LOS	*D*		Required Number of Lanes, N	

Glossary		Factor Location	
N - Number of lanes	S - Speed	E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
V - Hourly volume	D - Density	E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 11-18	TRD - Page 11-11
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 11-2, 11-3	
DDHV - Directional design hour volume			

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F-3891

RAMP ADD OR DROP LANE ANALYSIS (MAINLINE <55 MPH)

ATKINS

General Information

Date Performed:	7/25/2014	Freeway/Direction	I-26 WB
Analysis Year	2018 Build-River Center Site	Junction	On from 526 WB & EB
Analysis Time Period:	AM Peak	Segment ID	2218
Project Description:	Navy Base ICTF		

Inputs

	Mainline Upstream Ramp	Mainline Downstream Ramp	Ramp
Number of Lanes, N	1	2	1
Free-Flow Speed, FFS (mph)	55	55	55
Volume, V (veh/h)	1,800	3,133	1,333
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	13%	30%	54%
%RVs, P_R	0%	0%	0%

Performance Measures

	Upstream of Off-Ramp	Downstream of Off-Ramp	Off-Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.94	0.87	0.79
Demand Flow Rate, v_p (pc/h/ln)	2,130	2,002	1,881
Capacity Flow Rate, c (pc/h/ln)	2,200	2,200	2,200
v/c ratio	0.97	0.91	0.86
Density, D_{MD} (pc/mi/ln)	37.3	35.0	32.9
LOS	E	D	D

Formulas and Reference Material

$$f_{HV} = \frac{1}{1+P_T(E_T-1)+P_R(E_R-1)}$$ HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P}$$ HCM 2010, Equation 11-2

$$D_{MD} = \frac{0.0175*v_f}{N}$$ HCM 2010, Equation 13-26

Ramp Roadways Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

Diverge LOS Thresholds

LOS	Density (pc/mi/ln)
A	≤10
B	>10-20
C	>20-28
D	>28-35
E	>35
F	v/c > 1

Source: HCM 2010, Exhibit 13-2

RAMP ADD OR DROP LANE ANALYSIS (MAINLINE <55 MPH)

ATKINS

General Information

Date Performed:	7/25/2014	Freeway/Direction	I-26 WB
Analysis Year	2018 Build-River Center Site	Junction	On from 526 WB & EB
Analysis Time Period:	PM Peak	Segment ID	2218
Project Description:	Navy Base ICTF		

Inputs

	Mainline Upstream Ramp	Mainline Downstream Ramp	Ramp
Number of Lanes, N	1	2	1
Free-Flow Speed, FFS (mph)	55	55	55
Volume, V (veh/h)	2,082	3,687	1,605
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	10%	22%	39%
%RVs, P_R	0%	0%	0%

Performance Measures

	Upstream of Off-Ramp	Downstream of Off-Ramp	Off-Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.95	0.90	0.84
Demand Flow Rate, v_p (pc/h/ln)	2,429	2,274	2,131
Capacity Flow Rate, c (pc/h/ln)	2,200	2,200	2,200
v/c ratio	1.10	1.03	0.97
Density, D_{MD} (pc/mi/ln)	42.5	39.8	37.3
LOS	F	F	E

Formulas and Reference Material

$$f_{HV} = \frac{1}{1+P_T(E_T-1)+P_R(E_R-1)}$$ HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P}$$ HCM 2010, Equation 11-2

$$D_{MD} = \frac{0.0175*v_f}{N}$$ HCM 2010, Equation 13-26

Ramp Roadways Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

Diverge LOS Thresholds

LOS	Density (pc/mi/ln)
A	≤10
B	>10-20
C	>20-28
D	>28-35
E	>35
F	v/c > 1

Source: HCM 2010, Exhibit 13-2

Navy Base ICTF

FREEWAY WEAVING WORKSHEET

General Information

Analyst	AJR
Agency/Company	Atkins
Date Performed	7/25/2014
Analysis Time Period	AM Peak

Site Information

Freeway/Dir of Travel	I-26 WB
Weaving Segment Location	2220 - 526 to Rem/Aviation C-D
Analysis Year	2018 Build - River Center Site

Project Description *Navy Base ICTF*

Inputs

Weaving configuration	One-Sided
Weaving number of lanes, N	5
Weaving segment length, L_S	2285ft
Freeway free-flow speed, FFS	60 mph
Segment type	Freeway
Freeway minimum speed, S_{MIN}	15
Freeway maximum capacity, C_{IFL}	2300
Terrain type	Level

Conversions to pc/h Under Base Conditions

	V (veh/h)	PHF	Truck (%)	RV (%)	E_T	E_R	f_{HV}	fp	v (pc/h)
V_{FF}	1974	0.90	12	0	1.5	1.2	0.943	1.00	2325
V_{RF}	2451	0.90	30	0	1.5	1.2	0.870	1.00	3132
V_{FR}	550	0.90	12	0	1.5	1.2	0.943	1.00	648
V_{RR}	682	0.90	30	0	1.5	1.2	0.870	1.00	871
V_{NW}	3196							V =	6976
V_W	3780								
VR	0.542								

Configuration Characteristics

Minimum maneuver lanes, N_{WL}	3 lc	Minimum weaving lane changes, LC_{MIN}	lc/h
Interchange density, ID	0.7 int/mi	Weaving lane changes, LC_W	lc/h
Minimum RF lane changes, LC_{RF}	0 lc/pc	Non-weaving lane changes, LC_{NW}	lc/h
Minimum FR lane changes, LC_{FR}	1 lc/pc	Total lane changes, LC_{ALL}	lc/h
Minimum RR lane changes, LC_{RR}	lc/pc	Non-weaving vehicle index, I_{NW}	493

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment flow rate, v	6976 pc/h	Weaving intensity factor, W	
Weaving segment capacity, c_w	6094 veh/h	Weaving segment speed, S	mph
Weaving segment v/c ratio	1.080	Average weaving speed, S_W	mph
Weaving segment density, D	pc/mi/ln	Average non-weaving speed, S_{NW}	mph
Level of Service, LOS	F	Maximum weaving length, L_{MAX}	6754 ft

Notes

a. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments".
b. For volumes that exceed the weaving segment capacity, the level of service is "F".

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Navy Base ICTF

FREEWAY WEAVING WORKSHEET

General Information

Analyst	AJR
Agency/Company	Atkins
Date Performed	7/25/2014
Analysis Time Period	PM Peak

Site Information

Freeway/Dir of Travel	I-26 WB
Weaving Segment Location	2220 - 526 to Rem/Aviation C-D
Analysis Year	2018 Build - River Center Site

Project Description *Navy Base ICTF*

Inputs

Weaving configuration	One-Sided
Weaving number of lanes, N	5
Weaving segment length, L_S	2285ft
Freeway free-flow speed, FFS	60 mph
Segment type	Freeway
Freeway minimum speed, S_{MIN}	15
Freeway maximum capacity, C_{IFL}	2300
Terrain type	Level

Conversions to pc/h Under Base Conditions

	V (veh/h)	PHF	Truck (%)	RV (%)	E_T	E_R	f_{HV}	fp	v (pc/h)
V_{FF}	4038	0.90	10	0	1.5	1.2	0.952	1.00	4711
V_{RF}	3269	0.90	22	0	1.5	1.2	0.901	1.00	4032
V_{FR}	516	0.90	10	0	1.5	1.2	0.952	1.00	602
V_{RR}	418	0.90	22	0	1.5	1.2	0.901	1.00	516
V_{NW}	5227							V =	9861
V_W	4634								
VR	0.470								

Configuration Characteristics

Minimum maneuver lanes, N_{WL}	3 lc	Minimum weaving lane changes, LC_{MIN}	lc/h
Interchange density, ID	0.7 int/mi	Weaving lane changes, LC_W	lc/h
Minimum RF lane changes, LC_{RF}	0 lc/pc	Non-weaving lane changes, LC_{NW}	lc/h
Minimum FR lane changes, LC_{FR}	1 lc/pc	Total lane changes, LC_{ALL}	lc/h
Minimum RR lane changes, LC_{RR}	lc/pc	Non-weaving vehicle index, I_{NW}	

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment flow rate, v	9861 pc/h	Weaving intensity factor, W	
Weaving segment capacity, c_w	7093 veh/h	Weaving segment speed, S	mph
Weaving segment v/c ratio	1.324	Average weaving speed, S_W	mph
Weaving segment density, D	pc/mi/ln	Average non-weaving speed, S_{NW}	mph
Level of Service, LOS	F	Maximum weaving length, L_{MAX}	5911 ft

Notes

a. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments".
b. For volumes that exceed the weaving segment capacity, the level of service is "F".

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-26 WB*
Agency or Company	*Atkins*	From/To	*2225- Rem/Avia CD Off to CD On*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2018 Build - River Center Site*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*4425*	veh/h	Peak-Hour Factor, PHF	*0.90*	
AADT		veh/day	%Trucks and Buses, P_T	*15*	
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*	
Peak-Hr Direction Prop, D			General Terrain:	*Level*	
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*	

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.930*

Speed Inputs			Calc Speed Adj and FFS		
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f_{LW}		mph
Number of Lanes, N	*4*		f_{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	*60.0*	mph	FFS	*60.0*	mph
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures			Design (N)	
Operational (LOS)			Design (N)	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1321*	pc/h/ln	Design LOS	
S	*60.0*	mph	v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h/ln
D = v_p / S	*22.0*	pc/mi/ln	S	mph
LOS	*C*		D = v_p / S	pc/mi/ln
			Required Number of Lanes, N	

Glossary		Factor Location	
N - Number of lanes	S - Speed	E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
V - Hourly volume	D - Density	E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 11-18	TRD - Page 11-11
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 11-2, 11-3	
DDHV - Directional design hour volume			

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F-3896

BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-26 WB*
Agency or Company	*Atkins*	From/To	*2225- Rem/Avia CD Off to CD On*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*PM Peak*	Analysis Year	*2018 Build - River Center Site*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*7307*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*12*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.943*

Speed Inputs			Calc Speed Adj and FFS		
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f_{LW}		mph
Number of Lanes, N	*4*		f_{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	*60.0*	mph	FFS	*60.0*	mph
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures			Design (N)	
Operational (LOS)			Design (N)	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*2152*	pc/h/ln	Design LOS	
			v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h/ln
S	*54.5*	mph	S	mph
D = v_p / S	*39.5*	pc/mi/ln	D = v_p / S	pc/mi/ln
LOS	*E*		Required Number of Lanes, N	

Glossary		Factor Location	
N - Number of lanes	S - Speed	E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
V - Hourly volume	D - Density	E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 11-18	TRD - Page 11-11
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 11-2, 11-3	
DDHV - Directional design hour volume			

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F-3897

RAMP ADD OR DROP LANE ANALYSIS (MAINLINE <55 MPH)

ATKINS

General Information

Date Performed:	7/25/2014	Freeway/Direction	I-26 WB C-D
Analysis Year	2018 Build-River Center Site	Junction	WB Off to Remount
Analysis Time Period:	AM Peak	Segment ID	2230
Project Description:	Navy Base ICTF		

Inputs

	Mainline Upstream Ramp	Mainline Downstream Ramp	Ramp
Number of Lanes, N	2	1	1
Free-Flow Speed, FFS (mph)	55	55	45
Volume, V (veh/h)	1,232	744	488
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	3%	3%	2%
%RVs, P_R	0%	0%	0%

Performance Measures

	Upstream of Off-Ramp	Downstream of Off-Ramp	Off-Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.99	0.99	0.99
Demand Flow Rate, v_p (pc/h/ln)	695	839	548
Capacity Flow Rate, c (pc/h/ln)	2,200	2,200	2,100
v/c ratio	0.32	0.38	0.26
Density, D_{MD} (pc/mi/ln)	12.2	14.7	9.6
LOS	B	B	A

Formulas and Reference Material

$$f_{HV} = \frac{1}{1+P_T(E_T-1)+P_R(E_R-1)}$$ HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P}$$ HCM 2010, Equation 11-2

$$D_{MD} = \frac{0.0175*v_f}{N}$$ HCM 2010, Equation 13-26

Ramp Roadways Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

Diverge LOS Thresholds

LOS	Density (pc/mi/ln)
A	≤10
B	>10-20
C	>20-28
D	>28-35
E	>35
F	v/c > 1

Source: HCM 2010, Exhibit 13-2

RAMP ADD OR DROP LANE ANALYSIS (MAINLINE <55 MPH)

ATKINS

General Information

Date Performed:	7/25/2014	Freeway/Direction	I-26 WB C-D
Analysis Year	2018 Build-River Center Site	Junction	WB Off to Remount
Analysis Time Period:	PM Peak	Segment ID	2230
Project Description:	Navy Base ICTF		

Inputs

	Mainline Upstream Ramp	Mainline Downstream Ramp	Ramp
Number of Lanes, N	2	1	1
Free-Flow Speed, FFS (mph)	55	55	45
Volume, V (veh/h)	934	486	448
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	3%	4%	2%
%RVs, P_R	0%	0%	0%

Performance Measures

	Upstream of Off-Ramp	Downstream of Off-Ramp	Off-Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.99	0.98	0.99
Demand Flow Rate, v_p (pc/h/ln)	527	551	503
Capacity Flow Rate, c (pc/h/ln)	2,200	2,200	2,100
v/c ratio	0.24	0.25	0.24
Density, D_{MD} (pc/mi/ln)	9.2	9.6	8.8
LOS	A	A	A

Formulas and Reference Material

$$f_{HV} = \frac{1}{1+P_T(E_T-1)+P_R(E_R-1)}$$ HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P}$$ HCM 2010, Equation 11-2

$$D_{MD} = \frac{0.0175*v_f}{N}$$ HCM 2010, Equation 13-26

Ramp Roadways Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

Diverge LOS Thresholds

LOS	Density (pc/mi/ln)
A	≤10
B	>10-20
C	>20-28
D	>28-35
E	>35
F	v/c > 1

Source: HCM 2010, Exhibit 13-2

BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-26 WB C-D*
Agency or Company	*Atkins*	From/To	*2235-Remount Off to Remount On*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2018 Build - River Center Site*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*1488*	veh/h	Peak-Hour Factor, PHF	*0.90*	
AADT		veh/day	%Trucks and Buses, P_T	*3*	
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*	
Peak-Hr Direction Prop, D			General Terrain:	*Level*	
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*	

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.985*

Speed Inputs

Lane Width		ft
Rt-Side Lat. Clearance		ft
Number of Lanes, N	*2*	
Total Ramp Density, TRD		ramps/mi
FFS (measured)	*55.0*	mph
Base free-flow Speed, BFFS		mph

Calc Speed Adj and FFS

f_{LW}		mph
f_{LC}		mph
TRD Adjustment		mph
FFS	*55.0*	mph

LOS and Performance Measures

Operational (LOS)

v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*839*	pc/h/ln
S	*55.0*	mph
D = v_p / S	*15.3*	pc/mi/ln
LOS	*B*	

Design (N)

Design (N)

Design LOS		
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)		pc/h/ln
S		mph
D = v_p / S		pc/mi/ln
Required Number of Lanes, N		

Glossary

N - Number of lanes
V - Hourly volume
v_p - Flow rate
LOS - Level of service
S - Speed
D - Density
FFS - Free-flow speed
BFFS - Base free-flow speed
DDHV - Directional design hour volume

Factor Location

E_R - Exhibits 11-10, 11-12
E_T - Exhibits 11-10, 11-11, 11-13
f_p - Page 11-18
LOS, S, FFS, v_p - Exhibits 11-2, 11-3
f_{LW} - Exhibit 11-8
f_{LC} - Exhibit 11-9
TRD - Page 11-11

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-26 WB C-D*
Agency or Company	*Atkins*	From/To	*2235-Remount Off to Remount On*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*PM Peak*	Analysis Year	*2018 Build - River Center Site*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*972*	veh/h	Peak-Hour Factor, PHF	*0.90*
AADT		veh/day	%Trucks and Buses, P_T	*4*
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*
Peak-Hr Direction Prop, D			General Terrain:	*Level*
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.980*

Speed Inputs			Calc Speed Adj and FFS		
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f_{LW}		mph
Number of Lanes, N	*2*		f_{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	*55.0*	mph	FFS	*55.0*	mph
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures			Design (N)	
Operational (LOS)			Design (N)	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*551*	pc/h/ln	Design LOS	
			v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h/ln
S	*55.0*	mph	S	mph
D = v_p / S	*10.0*	pc/mi/ln	D = v_p / S	pc/mi/ln
LOS	*A*		Required Number of Lanes, N	

Glossary		Factor Location	
N - Number of lanes	S - Speed	E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
V - Hourly volume	D - Density	E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 11-18	TRD - Page 11-11
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 11-2, 11-3	
DDHV - Directional design hour volume			

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Navy Base ICTF

FREEWAY WEAVING WORKSHEET

General Information

Analyst	AJR
Agency/Company	Atkins
Date Performed	7/25/2014
Analysis Time Period	AM Peak

Site Information

Freeway/Dir of Travel	I-26 WB C-D
Weaving Segment Location	2240 - Remount to Aviation
Analysis Year	2018 Build - River Center Site

Project Description *Navy Base ICTF*

Inputs

Weaving configuration	One-Sided
Weaving number of lanes, N	2
Weaving segment length, L_S	750ft
Freeway free-flow speed, FFS	55 mph
Segment type	C-D Roadway/ Multilane Highways
Freeway minimum speed, S_{MIN}	15
Freeway maximum capacity, C_{IFL}	2250
Terrain type	Level

Conversions to pc/h Under Base Conditions

	V (veh/h)	PHF	Truck (%)	RV (%)	E_T	E_R	f_{HV}	f_p	v (pc/h)
V_{FF}	0	0.90	0	0	1.5	1.2	1.000	1.00	0
V_{RF}	254	0.90	18	0	1.5	1.2	0.917	1.00	308
V_{FR}	744	0.90	3	0	1.5	1.2	0.985	1.00	839
V_{RR}	0	0.90	0	0	1.5	1.2	1.000	1.00	0
V_{NW}	0							V =	1147
V_W	1147								
VR	1.000								

Configuration Characteristics

Minimum maneuver lanes, N_{WL}	2 lc	Minimum weaving lane changes, LC_{MIN}	1147 lc/h
Interchange density, ID	0.8 int/mi	Weaving lane changes, LC_W	1200 lc/h
Minimum RF lane changes, LC_{RF}	1 lc/pc	Non-weaving lane changes, LC_{NW}	21 lc/h
Minimum FR lane changes, LC_{FR}	1 lc/pc	Total lane changes, LC_{ALL}	1221 lc/h
Minimum RR lane changes, LC_{RR}	lc/pc	Non-weaving vehicle index, I_{NW}	0

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment flow rate, v	1147 pc/h	Weaving intensity factor, W	0.332
Weaving segment capacity, c_w	2400 veh/h	Weaving segment speed, S	45.0 mph
Weaving segment v/c ratio	0.478	Average weaving speed, S_W	45.0 mph
Weaving segment density, D	12.7 pc/mi/ln	Average non-weaving speed, S_{NW}	44.0 mph
Level of Service, LOS	B	Maximum weaving length, L_{MAX}	14232 ft

Notes

a. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments".
b. For volumes that exceed the weaving segment capacity, the level of service is "F".

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Navy Base ICTF

FREEWAY WEAVING WORKSHEET

General Information

Analyst	AJR
Agency/Company	Atkins
Date Performed	7/25/2014
Analysis Time Period	PM Peak

Site Information

Freeway/Dir of Travel	I-26 WB C-D
Weaving Segment Location	2240 - Remount to Aviation
Analysis Year	2018 Build - River Center Site

Project Description *Navy Base ICTF*

Inputs

Weaving configuration	One-Sided
Weaving number of lanes, N	2
Weaving segment length, L_S	750ft
Freeway free-flow speed, FFS	55 mph
Segment type	C-D Roadway/ Multilane Highways
Freeway minimum speed, S_{MIN}	15
Freeway maximum capacity, C_{IFL}	2250
Terrain type	Level

Conversions to pc/h Under Base Conditions

	V (veh/h)	PHF	Truck (%)	RV (%)	E_T	E_R	f_{HV}	f_p	v (pc/h)
V_{FF}	0	0.90	0	0	1.5	1.2	1.000	1.00	0
V_{RF}	924	0.90	4	0	1.5	1.2	0.980	1.00	1047
V_{FR}	486	0.90	4	0	1.5	1.2	0.980	1.00	551
V_{RR}	0	0.90	0	0	1.5	1.2	1.000	1.00	0
V_{NW}	0							V =	1598
V_W	1598								
VR	1.000								

Configuration Characteristics

Minimum maneuver lanes, N_{WL}	2 lc	Minimum weaving lane changes, LC_{MIN}	1598 lc/h
Interchange density, ID	0.8 int/mi	Weaving lane changes, LC_W	1651 lc/h
Minimum RF lane changes, LC_{RF}	1 lc/pc	Non-weaving lane changes, LC_{NW}	21 lc/h
Minimum FR lane changes, LC_{FR}	1 lc/pc	Total lane changes, LC_{ALL}	1672 lc/h
Minimum RR lane changes, LC_{RR}	lc/pc	Non-weaving vehicle index, I_{NW}	0

Weaving Segment Speed, Density, Level of Service, and Capacity

Weaving segment flow rate, v	1598 pc/h	Weaving intensity factor, W	0.425
Weaving segment capacity, c_w	2400 veh/h	Weaving segment speed, S	43.1 mph
Weaving segment v/c ratio	0.666	Average weaving speed, S_W	43.1 mph
Weaving segment density, D	18.6 pc/mi/ln	Average non-weaving speed, S_{NW}	39.7 mph
Level of Service, LOS	B	Maximum weaving length, L_{MAX}	14232 ft

Notes

a. Weaving segments longer than the calculated maximum length should be treated as isolated merge and diverge areas using the procedures of Chapter 13, "Freeway Merge and Diverge Segments".
b. For volumes that exceed the weaving segment capacity, the level of service is "F".

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BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-26 WB C-D*
Agency or Company	*Atkins*	From/To	*2245 - Avia Off to Avia EB On*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*AM Peak*	Analysis Year	*2018 Build - River Center Site*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*508*	veh/h	Peak-Hour Factor, PHF	*0.90*	
AADT		veh/day	%Trucks and Buses, P_T	*18*	
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*	
Peak-Hr Direction Prop, D			General Terrain:	*Level*	
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*	

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.917*

Speed Inputs			Calc Speed Adj and FFS		
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f_{LW}		mph
Number of Lanes, N	*2*		f_{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	*55.0*	mph	FFS	*55.0*	mph
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures			Design (N)	
Operational (LOS)			Design (N)	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*308*	pc/h/ln	Design LOS	
			v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h/ln
S	*55.0*	mph	S	mph
D = v_p / S	*5.6*	pc/mi/ln	D = v_p / S	pc/mi/ln
LOS	*A*		Required Number of Lanes, N	

Glossary		Factor Location	
N - Number of lanes	S - Speed	E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
V - Hourly volume	D - Density	E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 11-18	TRD - Page 11-11
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 11-2, 11-3	
DDHV - Directional design hour volume			

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F-3904

BASIC FREEWAY SEGMENTS WORKSHEET

General Information		Site Information	
Analyst	*AJR*	Highway/Direction of Travel	*I-26 WB C-D*
Agency or Company	*Atkins*	From/To	*2245 - Avia Off to Avia EB On*
Date Performed	*7/25/2014*	Jurisdiction	
Analysis Time Period	*PM Peak*	Analysis Year	*2018 Build - River Center Site*

Project Description *Navy Base ICTF*

☑ Oper.(LOS) ☐ Des.(N) ☐ Planning Data

Flow Inputs

Volume, V	*1848*	veh/h	Peak-Hour Factor, PHF	*0.90*	
AADT		veh/day	%Trucks and Buses, P_T	*4*	
Peak-Hr Prop. of AADT, K			%RVs, P_R	*0*	
Peak-Hr Direction Prop, D			General Terrain:	*Level*	
DDHV = AADT x K x D		veh/h	Grade % Length Up/Down %	*mi*	

Calculate Flow Adjustments

f_p	*1.00*	E_R	*1.2*
E_T	*1.5*	$f_{HV} = 1/[1+P_T(E_T - 1) + P_R(E_R - 1)]$	*0.980*

Speed Inputs			Calc Speed Adj and FFS		
Lane Width		ft			
Rt-Side Lat. Clearance		ft	f_{LW}		mph
Number of Lanes, N	*2*		f_{LC}		mph
Total Ramp Density, TRD		ramps/mi	TRD Adjustment		mph
FFS (measured)	*55.0*	mph	FFS	*55.0*	mph
Base free-flow Speed, BFFS		mph			

LOS and Performance Measures			Design (N)	
Operational (LOS)			Design (N)	
v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	*1047*	pc/h/ln	Design LOS	
S	*55.0*	mph	v_p = (V or DDHV) / (PHF x N x f_{HV} x f_p)	pc/h/ln
D = v_p / S	*19.0*	pc/mi/ln	S	mph
LOS	*C*		D = v_p / S	pc/mi/ln
			Required Number of Lanes, N	

Glossary		Factor Location	
N - Number of lanes	S - Speed	E_R - Exhibits 11-10, 11-12	f_{LW} - Exhibit 11-8
V - Hourly volume	D - Density	E_T - Exhibits 11-10, 11-11, 11-13	f_{LC} - Exhibit 11-9
v_p - Flow rate	FFS - Free-flow speed	f_p - Page 11-18	TRD - Page 11-11
LOS - Level of service	BFFS - Base free-flow speed	LOS, S, FFS, v_p - Exhibits 11-2, 11-3	
DDHV - Directional design hour volume			

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RAMP ADD OR DROP LANE ANALYSIS (MAINLINE <55 MPH)

ATKINS

General Information

Date Performed:	7/25/2014	Freeway/Direction	I-26 WB C-D
Analysis Year	2018 Build-River Center Site	Junction	WB On from Aviation EB
Analysis Time Period:	AM Peak	Segment ID	2250
Project Description:	Navy Base ICTF		

Inputs

	Mainline Upstream Ramp	Mainline Downstream Ramp	Ramp
Number of Lanes, N	1	1	1
Free-Flow Speed, FFS (mph)	55	55	25
Volume, V (veh/h)	254	274	20
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	18%	18%	25%
%RVs, P_R	0%	0%	0%

Performance Measures

	Upstream of Off-Ramp	Downstream of Off-Ramp	Off-Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.92	0.92	0.89
Demand Flow Rate, v_p (pc/h/ln)	308	332	25
Capacity Flow Rate, c (pc/h/ln)	2,200	2,200	1,900
v/c ratio	0.14	0.15	0.01
Density, D_{MD} (pc/mi/ln)	5.4	5.8	0.4
LOS	A	A	A

Formulas and Reference Material

$$f_{HV} = \frac{1}{1+P_T(E_T-1)+P_R(E_R-1)}$$ HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P}$$ HCM 2010, Equation 11-2

$$D_{MD} = \frac{0.0175*v_f}{N}$$ HCM 2010, Equation 13-26

Ramp Roadways Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

Diverge LOS Thresholds

LOS	Density (pc/mi/ln)
A	≤10
B	>10-20
C	>20-28
D	>28-35
E	>35
F	v/c > 1

Source: HCM 2010, Exhibit 13-2

RAMP ADD OR DROP LANE ANALYSIS (MAINLINE <55 MPH)

ATKINS

General Information

Date Performed:	7/25/2014	Freeway/Direction	I-26 WB C-D
Analysis Year	2018 Build-River Center Site	Junction	WB On from Aviation EB
Analysis Time Period:	PM Peak	Segment ID	2250
Project Description:	Navy Base ICTF		

Inputs

	Mainline Upstream Ramp	Mainline Downstream Ramp	Ramp
Number of Lanes, N	1	1	1
Free-Flow Speed, FFS (mph)	55	55	25
Volume, V (veh/h)	924	1,308	384
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	4%	3%	2%
%RVs, P_R	0%	0%	0%

Performance Measures

	Upstream of Off-Ramp	Downstream of Off-Ramp	Off-Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.98	0.99	0.99
Demand Flow Rate, v_p (pc/h/ln)	1,047	1,475	431
Capacity Flow Rate, c (pc/h/ln)	2,200	2,200	1,900
v/c ratio	0.48	0.67	0.23
Density, D_{MD} (pc/mi/ln)	18.3	25.8	7.5
LOS	B	C	A

Formulas and Reference Material

$$f_{HV} = \frac{1}{1+P_T(E_T-1)+P_R(E_R-1)}$$ HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P}$$ HCM 2010, Equation 11-2

$$D_{MD} = \frac{0.0175*v_f}{N}$$ HCM 2010, Equation 13-26

Ramp Roadways Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

Diverge LOS Thresholds

LOS	Density (pc/mi/ln)
A	≤10
B	>10-20
C	>20-28
D	>28-35
E	>35
F	v/c > 1

Source: HCM 2010, Exhibit 13-2

RAMP ADD OR DROP LANE ANALYSIS (MAINLINE <55 MPH)

ATKINS

General Information

Date Performed:	7/25/2014	Freeway/Direction	I-26 WB C-D
Analysis Year	2018 Build-River Center Site	Junction	WB On from Aviation WB
Analysis Time Period:	AM Peak	Segment ID	2260
Project Description:	Navy Base ICTF		

Inputs

	Mainline Upstream Ramp	Mainline Downstream Ramp	Ramp
Number of Lanes, N	1	1	1
Free-Flow Speed, FFS (mph)	55	55	45
Volume, V (veh/h)	274	363	89
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	18%	18%	19%
%RVs, P_R	0%	0%	0%

Performance Measures

	Upstream of Off-Ramp	Downstream of Off-Ramp	Off-Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.92	0.92	0.91
Demand Flow Rate, v_p (pc/h/ln)	332	440	108
Capacity Flow Rate, c (pc/h/ln)	2,200	2,200	2,100
v/c ratio	0.15	0.20	0.05
Density, D_{MD} (pc/mi/ln)	5.8	7.7	1.9
LOS	A	A	A

Formulas and Reference Material

$$f_{HV} = \frac{1}{1+P_T(E_T-1)+P_R(E_R-1)}$$ HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P}$$ HCM 2010, Equation 11-2

$$D_{MD} = \frac{0.0175*v_f}{N}$$ HCM 2010, Equation 13-26

Ramp Roadways Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

Diverge LOS Thresholds

LOS	Density (pc/mi/ln)
A	≤10
B	>10-20
C	>20-28
D	>28-35
E	>35
F	v/c > 1

Source: HCM 2010, Exhibit 13-2

RAMP ADD OR DROP LANE ANALYSIS (MAINLINE <55 MPH)

ATKINS

General Information

Date Performed:	7/25/2014	Freeway/Direction	I-26 WB C-D
Analysis Year	2018 Build-River Center Site	Junction	WB On from Aviation WB
Analysis Time Period:	PM Peak	Segment ID	2260
Project Description:	Navy Base ICTF		

Inputs

	Mainline Upstream Ramp	Mainline Downstream Ramp	Ramp
Number of Lanes, N	1	1	1
Free-Flow Speed, FFS (mph)	55	55	45
Volume, V (veh/h)	1,308	1,764	456
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	3%	3%	3%
%RVs, P_R	0%	0%	0%

Performance Measures

	Upstream of Off-Ramp	Downstream of Off-Ramp	Off-Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.99	0.99	0.99
Demand Flow Rate, v_p (pc/h/ln)	1,475	1,989	514
Capacity Flow Rate, c (pc/h/ln)	2,200	2,200	2,100
v/c ratio	0.67	0.90	0.24
Density, D_{MD} (pc/mi/ln)	25.8	34.8	9.0
LOS	C	D	A

Formulas and Reference Material

$$f_{HV} = \frac{1}{1+P_T(E_T-1)+P_R(E_R-1)}$$ HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P}$$ HCM 2010, Equation 11-2

$$D_{MD} = \frac{0.0175*v_f}{N}$$ HCM 2010, Equation 13-26

Ramp Roadways Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

Diverge LOS Thresholds

LOS	Density (pc/mi/ln)
A	≤10
B	>10-20
C	>20-28
D	>28-35
E	>35
F	v/c > 1

Source: HCM 2010, Exhibit 13-2

FREEWAY RAMP ADD OR DROP LANE ANALYSIS

ATKINS

General Information

Date Performed:	7/25/2014	Freeway/Direction	I-26 WB
Analysis Year	2018 Build-River Center Site	Junction	From Rem/Aviation C-D
Analysis Time Period:	AM Peak	Segment ID	2270
Project Description:	Navy Base ICTF		

Inputs

	Freeway Upstream of Off-Ramp	Freeway Downstream of Off-Ramp	Off-Ramp
Number of Lanes, N	4	5	1
Free-Flow Speed, FFS (mph)	60	60	55
Volume, V (veh/h)	4,425	4,788	363
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	15%	14%	18%
%RVs, P_R	0%	0%	0%

Performance Measures

	Freeway Upstream Ramp	Freeway Downstream Ramp	Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.93	0.93	0.92
Demand Flow Rate, v_p (pc/h/ln)	1,321	1,138	440
Capacity Flow Rate, c (pc/h/ln)	2,300	2,300	2,200
v/c ratio	0.57	0.49	0.20
Density, D_{MD} (pc/mi/ln)	23.1	19.9	7.7
LOS	C	B	A

Formulas and Reference Material

$$f_{HV} = \frac{1}{1 + P_T(E_T-1)+P_R(E_R-1)}$$ HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P}$$ HCM 2010, Equation 11-2

$$D_{MD} = \frac{0.0175*v_f}{N}$$ HCM 2010, Equation 13-26

Basic Freeway Segments Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
75	2,400
70	2,400
65	2,350
60	2,300
55	2,250

Source: HCM 2010, Exhibit 11-17

Ramp Roadways Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

Diverge LOS Thresholds

LOS	Density (pc/mi/ln)
A	≤10
B	>10-20
C	>20-28
D	>28-35
E	>35
F	v/c > 1

Source: HCM 2010, Exhibit 13-2

FREEWAY RAMP ADD OR DROP LANE ANALYSIS

ATKINS

General Information

Date Performed:	7/25/2014	Freeway/Direction	I-26 WB
Analysis Year	2018 Build-River Center Site	Junction	From Rem/Aviation C-D
Analysis Time Period:	PM Peak	Segment ID	2270
Project Description:	Navy Base ICTF		

Inputs

	Freeway Upstream of Ramp	Freeway Downstream of Ramp	Ramp
Number of Lanes, N	4	5	1
Free-Flow Speed, FFS (mph)	60	60	55
Volume, V (veh/h)	7,307	9,071	1,764
Driver Population, f_P	1	1	1
General Terrain	Level	Level	Level
Peak Hour Factor, PHF	0.90	0.90	0.90
%Trucks and Buses, P_T	12%	11%	3%
%RVs, P_R	0%	0%	0%

Performance Measures

	Freeway Upstream Ramp	Freeway Downstream Ramp	Ramp
Heavy Vehicle Adjustment Factor, f_{HV}	0.94	0.95	0.99
Demand Flow Rate, v_p (pc/h/ln)	2,152	2,127	1,989
Capacity Flow Rate, c (pc/h/ln)	2,300	2,300	2,200
v/c ratio	0.94	0.92	0.90
Density, D_{MD} (pc/mi/ln)	37.7	37.2	34.8
LOS	E	E	D

Formulas and Reference Material

$$f_{HV} = \frac{1}{1 + P_T(E_T-1)+P_R(E_R-1)}$$ HCM 2010, Equation 11-3

$$V_p = \frac{V}{PHF*N*f_{HV}*f_P}$$ HCM 2010, Equation 11-2

$$D_{MD} = \frac{0.0175*v_f}{N}$$ HCM 2010, Equation 13-26

Basic Freeway Segments Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
75	2,400
70	2,400
65	2,350
60	2,300
55	2,250

Source: HCM 2010, Exhibit 11-17

Ramp Roadways Max Service Flow Rates

FFS (mi/h)	Capacity (pc/h/ln)
> 50	2,200
>40-50	2,100
>30-40	2,000
≥20-30	1,900
<20	1,800

Source: HCM 2010, Exhibit 13-10

Diverge LOS Thresholds

LOS	Density (pc/mi/ln)
A	≤10
B	>10-20
C	>20-28
D	>28-35
E	>35
F	v/c > 1

Source: HCM 2010, Exhibit 13-2